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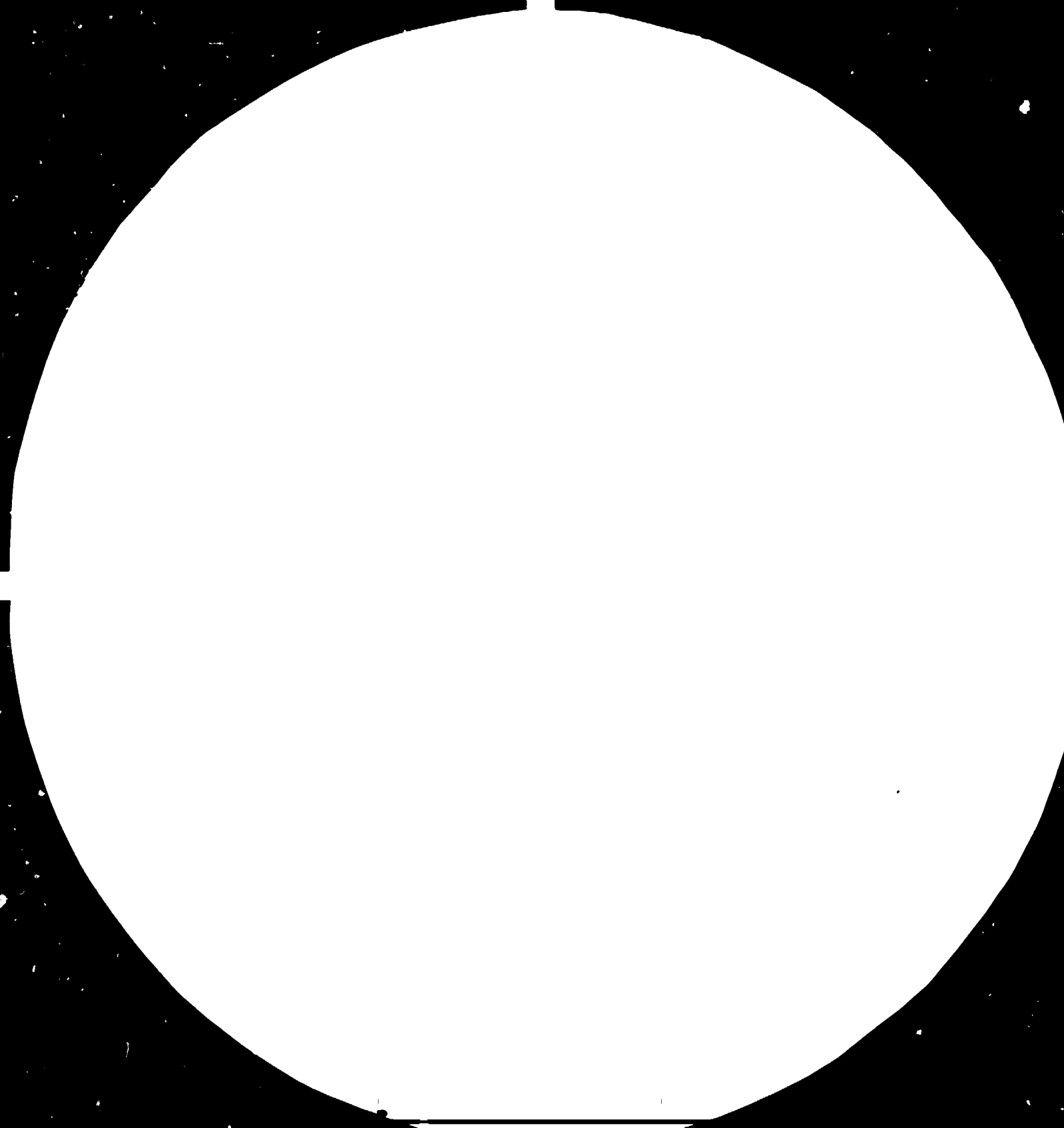

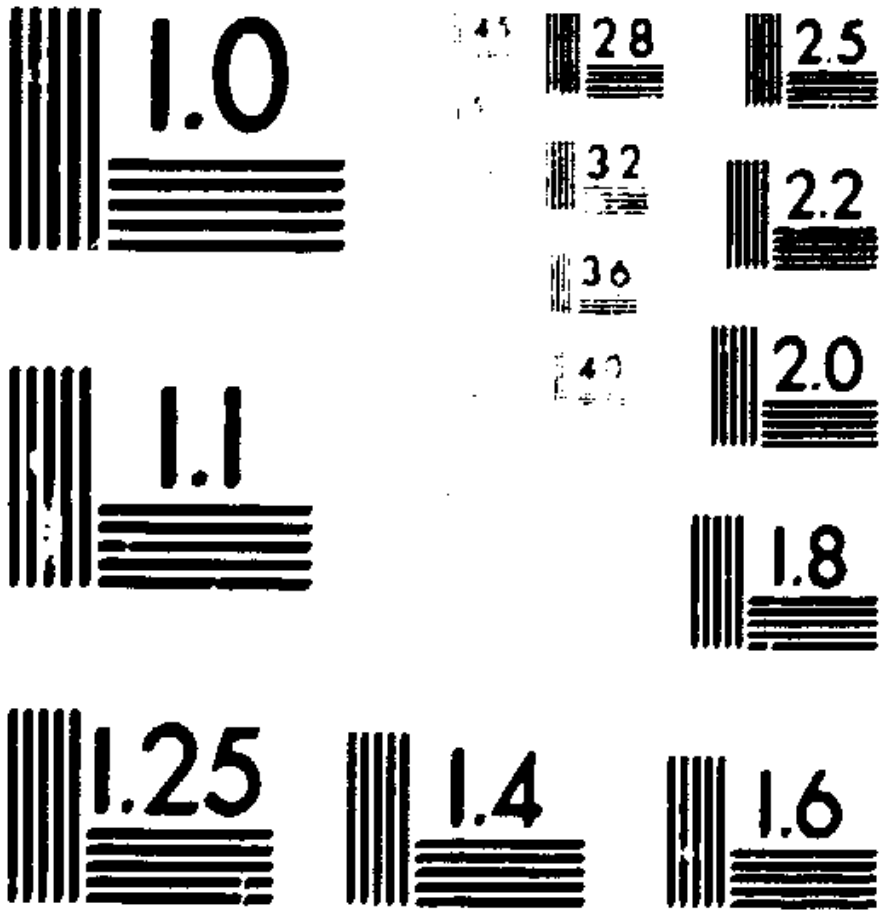

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RESEARCH AND DEVELOPMENT IN FOOD PROCESSING AND PACKAGING TECHNOLOGY

DP/MEX/82/010

MEXICO

Technical report: the development of plastic packaging

Prepared for the Government of Mexico
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of M. Bouyer,
consultant in the production of plastic packages

United Nations Industrial Development Organization
Vienna

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Explanatory notes

References to dollars ($) are to United States dollars.

The monetary unit in Mexico is the peso ($Mex). During the period covered by the report, the value of the peso in relation to the United States dollar was $US 1 = $Mex 143.8.

Besides the common abbreviations, symbols and terms, the following have been used in this report:

Organization

LANFI	Laboratorios Nacionales de Fomento Industrial (National Laboratories for Industrial Promotion)

Technical abbreviations

EVA	ethylene-vinyl acetate
HDPE	high-density polyethylene
LDPE	low-density polyethylene
MDPE	medium-density polyethylene
OPP	oriented polypropylene
PVC	polyvinyl chloride

Mention of firm names and commercial products does not imply the endorsement of the United Nations.

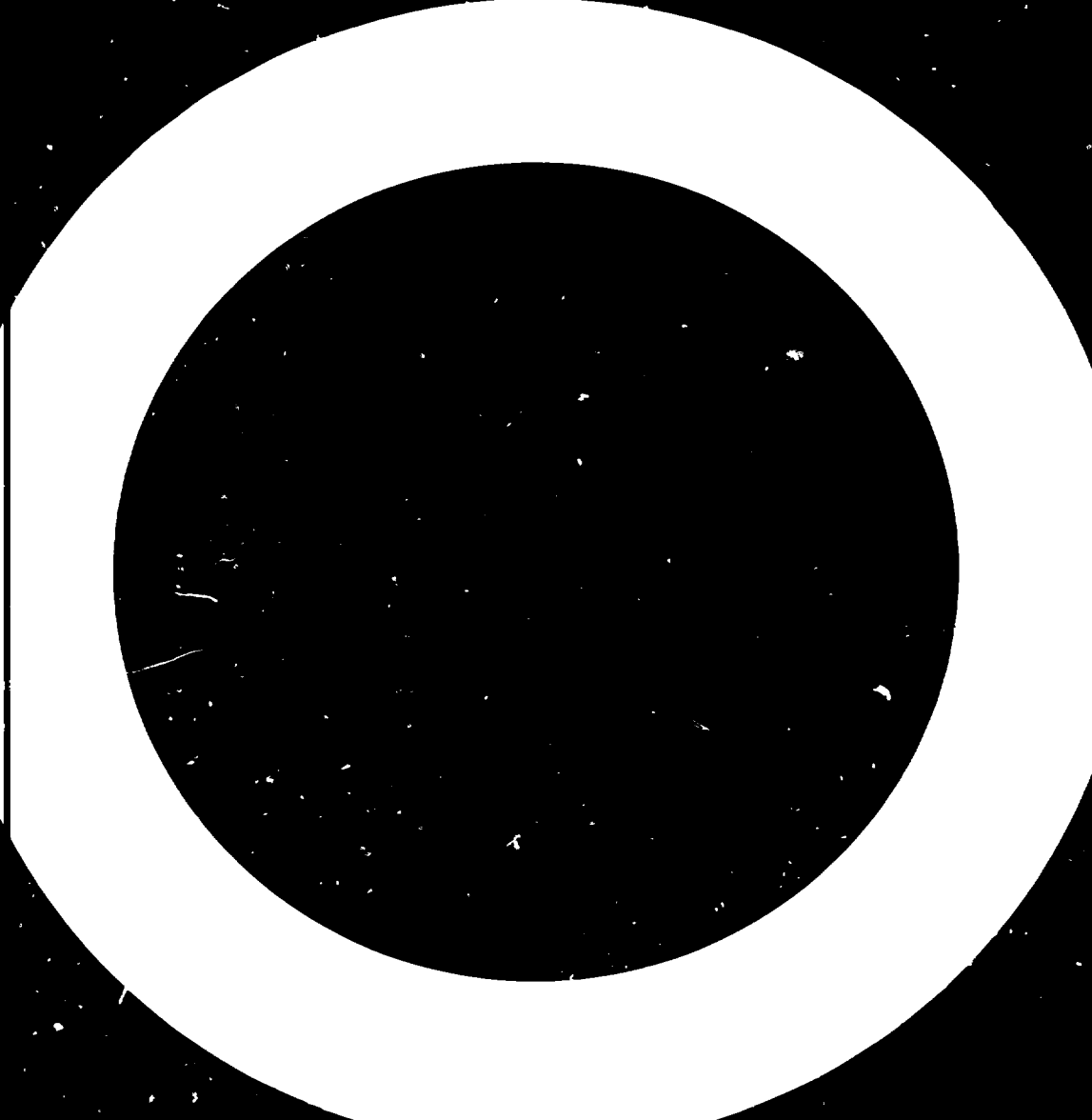
SUMMARY

This report on the development of plastic packaging has been prepared as part of the project, "Research and development in food processing and packaging technology" (DP/MEX/82/010), which is being carried out for the Government of Mexico by the United Nations Industrial Development Organization (UNIDO), acting as executing agency for the United Nations Development Programme (UNDP).

The present report is the result of a one-month mission (from 24 September to 23 October 1984) to Mexico City by M. Bouyer, an expert in the production of plastic packaging. The aim of the mission was to assist the Government in designing a national policy for the production and consumption of plastic packaging.

The report covers production and consumption trends and technological developments in the plastic packaging industry world-wide and describes the present situation and prospects of this industrial sector in Mexico. The production capabilities of various companies visited by the expert are described, the compatibility between various kinds of packaging materials and kinds of foods is discussed, and the different types of packaging machines are briefly described.

A number of recommendations are made for increasing or introducing production of the raw materials needed and for their conversion into packaging; for improvements in process technology and quality control; and for increasing the flow of information and assistance to the end users of the products of the plastic packaging sector.

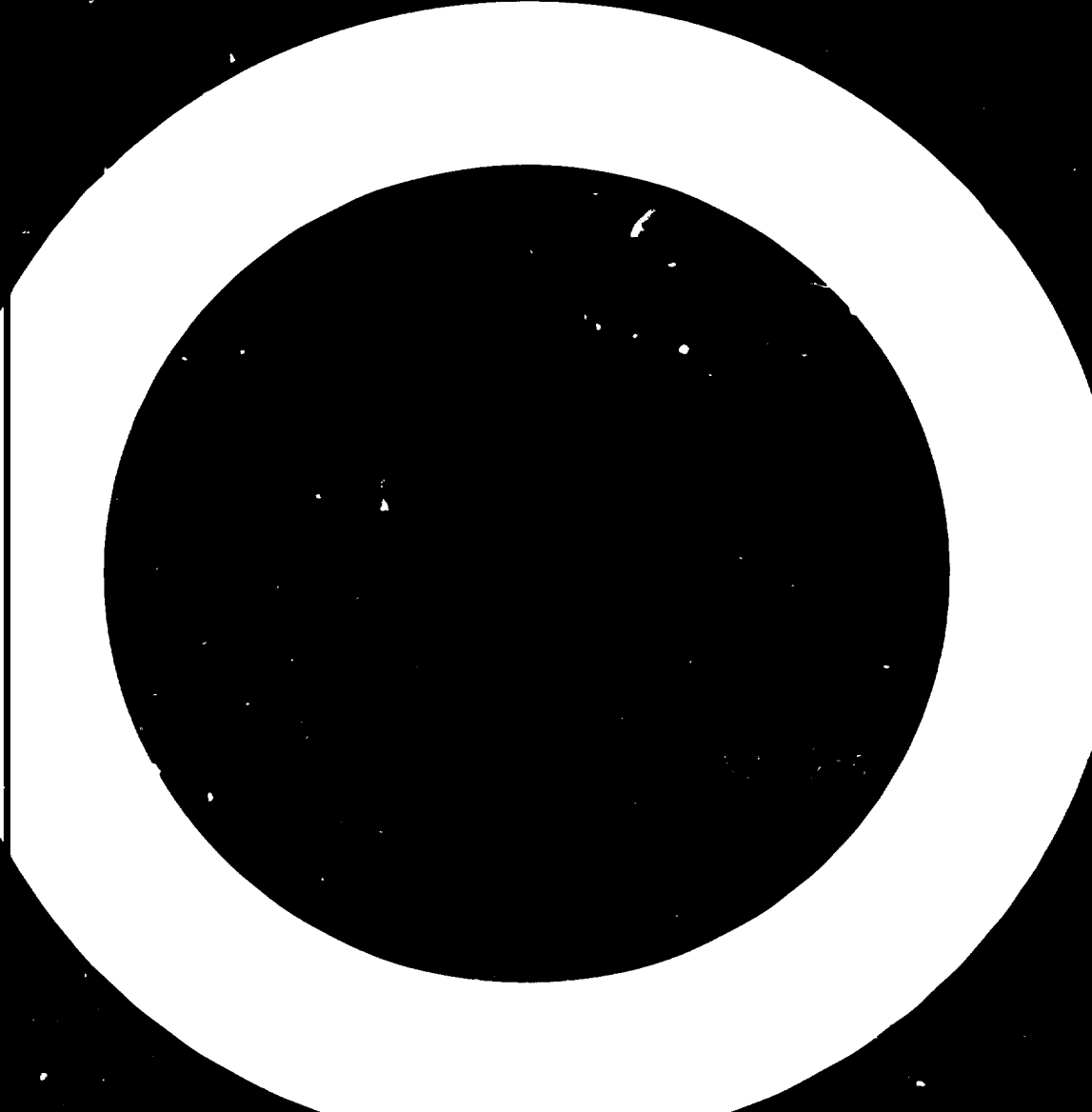


CONTENTS

		Page
	INTRODUCTION	7
	CONCLUSIONS AND SUMMARY OF RECOMMENDATIONS	9
Chapter		
I.	PLASTICS AND THE PACKAGING INDUSTRY	10
	A. Developments in plastics	10
	B. Plastics in packaging	10
	C. World trends in plastic packaging	12
II.	THE PLASTIC PACKAGING INDUSTRY IN MEXICO	16
	A. Production and consumption of cellophane compared to that of oriented polypropylene	16
	B. Production and consumption of low-density polyethylene	18
	C. Production and consumption of high-density polyethylene	19
	D. Consumption of polypropylene	19
	E. Production and consumption of polyvinyl chloride	20
	F. Production of flexible converted packaging	22
	G. Forecast consumption of plastics in packaging in 1985	23
III.	VISITS TO RAW-MATERIAL PRODUCERS AND CONVERTERS	25
	A. Polietileno National de Mexico	25
	B. Celloprint	25
	C. Rotoplas	27
	D. Celanese Mexicana (CELMEX)	27
	E. Grafo Regia (Monterrey)	28
	F. Polycid	29
IV.	SUITABILITY OF PACKAGING FOR DIFFERENT FOOD PRODUCTS	30
V.	PACKAGING MACHINES	32
VI.	DETAILED RECOMMENDATIONS	33
Annex.	Job description	37

Figures

I.	Consumption and forecast consumption of cellophane and OPP up to 1990	17
II.	Consumption and forecast consumption of polypropylene up to 1986	21



INTRODUCTION

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The present report is the result of a one-month mission (from 24 September to 23 October 1984) to Mexico City by M. Bouyer, an expert in the production of plastic packaging. The aim of the mission was to assist the Government in designing a national policy for the production and consumption of plastic packaging, to draw up guidelines for the development of the manufacturing industries in this sector in accordance with national economic needs and priorities and to advise on rationalization of the packaging machinery used in the country. (The job description is given in the annex.)

Project background

In its present economic stage, Mexico's domestic production has not yet caught up with the demands of domestic consumption in this field. This imbalance has had to be made up by imports or by limiting domestic consumption. However, reliance on imports is clearly undesirable in the light of the present economic situation and the Government's industrial development programme aims to reduce imports generally, eliminate non-essential imports and build up national production capacity to replace imports and eventually to provide a surplus for export. Until this stage is reached, growth in domestic consumption is to be discouraged and incentives provided for growth in domestic production. Certain dangers are associated with this stage, namely that insufficient attention will be paid to the quality of the products and to the needs of the end users.

Mexico faces a number of problems in the present and future development of plastic packaging materials which can only be solved in a realistic and concrete way if a coherent policy is followed at all levels of the packaging industry.

The situation is made more complex by the enormous diversification of different plastic materials and the flow of technical innovations coming from industrialized countries. Mexico has to consider what industrial choices are most realistic and will be of most benefit to its economy.

This process begins with better information and a better knowledge of plastic materials, with better communication between the different partners in the packaging field and also the end user, whose needs, it must be said, are the most important factor in making a choice between industrial options.

The principal governmental guideline is to reduce imports as far as possible and to increase the volume of production. As far as packaging is concerned, this means that national production has to rise to the level of domestic demand for packaging, in volume, in variety of types and in quality.

The plastics section of the packaging industry is essentially a converting industry, generating added value by transforming basic plastics into packaging materials. It is not an independent but an intermediate economic activity and must be looked on as a service industry. Its products must satisfy many other different industries which in turn have their own problems.

It is usually the packaging which has to ensure that goods, especially perishable ones, reach the consumer in a satisfactory condition. The packaging industry therefore has a serious responsibility to maintain its standards and the quality of its products and to pursue advances in technology. The suggestions made in this report are made in the light of these considerations and in the general spirit of the national economic plan guidelines.

CONCLUSIONS AND SUMMARY OF RECOMMENDATIONS

Conclusions

1. Despite current recession and rigorous economic policies, the underlying trends in Mexico such as rapid population growth, the increasing youth of the population, the increase in the supermarket type of food-product distribution and the popularity of new styles of food purchasing and presentation, all suggest that the demand for packaging will continue to grow.

2. Since Mexico is a large producer of crude oil, the most obvious material to choose for the development of its packaging industry would be plastic.

3. This means that Mexico must seek to develop its petrochemical industries.

4. All recommendations for the development of the packaging industry depend on the country's willingness to move towards autonomy in the production of plastic raw materials.

Recommendations

(These are given in greater detail in chapter VI.)

1. The production capacity for low-density polyethylene should be increased.

2. The quality control of polyethylene resins should be improved and accurate specifications given for the types of resin appropriate for each kind of end use.

3. The quality of low-density polyethylene films for lamination should be improved.

4. Polypropylene resin should be produced in Mexico.

5. The production of simple and cheap packaging by the smaller, local converting firms should be encouraged.

6. It is desirable to introduce production of PVC bottles in the plants which produce the liquid which they will contain.

7. The production of vacuum metallized films should be encouraged.

8. The production of oriented nylon film for use in laminates should be promoted.

9. Some improvements should be made in the various technological processes used.

10. The use of co-extrusion technology for packaging should be promoted.

11. More information and technical assistance should be made available to the end users.

I. PLASTICS AND THE PACKAGING INDUSTRY

A. Developments in plastics

In the field of plastic materials, the evolution of products, the generation of new types, the evolution of technology and of industrial processes has been very fast. However, advantage can only be taken of this wide choice of industrial options in a situation of economic growth. The influence of technical and economic factors is so important that it is necessary to keep permanently informed about the latest international technical and technological developments.

First of all, it is necessary to remember that, during the last years, plastic materials have evolved considerably, not so much in the field of new molecules, but through a very large diversification of the already-known formulations. This is due to a better mastery of and a better knowledge of molecular structures which has made possible modifications towards greater specificity of function and the development of new properties. The new processes in the production of raw materials, the increasingly frequent use of copolymerization and the new converting technologies open the door to a number of new lines of products with very specific uses.

Thus each type of plastic now has a family of materials of greater or lesser importance with which the packaging technologist must become familiar. At the same time, the accuracy of standardization in the production of these different types of materials has greatly increased. In the past, the structure of these materials was less well understood and the results of production were somewhat unpredictable so that, at that time, users considered plastic products to be of bad quality and poor reliability.

B. Plastics in packaging

Figures show that, for all countries, the packaging industry accounts for about 30 per cent of the total consumption of plastics. This indicates the importance of packaging in the global development of plastic materials. All the plastic packaging materials come from the petrochemical industry and are produced by the route of steam cracking and polymerization, copolymerization and polycondensation processes.

The total production of plastics by the petrochemical industry only represents 5 per cent of the total consumption of crude oil. It is therefore a factor of little weight in the oil policy of most countries. However, it is important to remember that the part of crude oil which is used for the distillation of petrochemical products is different from that used for gas, petrol or fuel oil. This part is called naphta and is too heavy for gas and too light for petrol. Consequently, the use of this part for plastics does not detract in any way from the supply of gas and petrol.

The packaging industry uses plastic materials mainly in the following forms:

(a) Films (with a gauge of 300 microns or less);

(b) Sheets (with a gauge of over 300 microns);

(c) Extruded bottles;

(d) Moulded pieces.

In accordance with what has been said previously, the development of plastic materials in the packaging field has always grown and continues to grow, in spite of economic crisis. Its rate of growth has been and continues to be higher than the growth rate in total packaging. This is due to the fact that many end users are moving from paper, cardboard and glass toward the plastic materials all the time. This is because of the number of advantages which plastics have, such as:

Low cost
Low weight
Easy to convert
Sealable
Low energy cost
Chemically inert
Can provide odour, oxygen, moisture and temperature barriers

It is important to remember, at the outset of our study, what the five tasks of packaging are and how these tasks can be accomplished by the various plastic materials in relation to the type of product that must be wrapped, the type of packaging machinery and the style of distribution. The tasks of packaging (and the qualities required of the packaging material) are:

(a) To protect the product in transportation (the mechanical properties and the gauge of the material are important);

(b) To enclose and isolate the product (the ability of the material to be heat sealed);

(c) To define a sales unit or consumer portion (the machinability of the material in packaging machines);

(d) To increase the product's shelf life (the impermeability of the material to moisture, oxygen etc.);

(e) To transmit a message (the material's printability).

Today, points (d) and (e) are the most important. All the principal improvements made in film concern those points. We ought not to take the attitude that all the current emphasis on improving the quality and diversification of packaging is the result of oversophistication in the industrialized countries and is not appropriate to developing economies. We have seen that when the industrialized countries were affected by economic crisis, although the volume of demand for packaging was adversely affected, the importance of quality, diversity and specific performance increased, precisely because factors such as reduced cost, increased length of storage time and distribution distance, improved productivity and reduction of waste had become more important to the end users.

The raw materials used in plastic packaging are the following:

Polyolefins:

Low-density polyethylene (LDPE)
Medium-density polyethylene (MDPE)
High-density polyethylene (HDPE)
Cast polypropylene
Oriented polypropylene (OPP)
Ethylene-vinyl acetate (copolymer) (EVA)

Surlyn (ionomer)
Linear low-density polyethylene

Polyvinyl chloride (PVC):

Non-plasticized PVC
Plasticized PVC
Stretch film

Polystyrene:

Thick films
Expanded polystyrene

Polyester

Polyamides:

Nylon 6
Bi-axially oriented polyamid

Regenerated cellulose film:

Cellophane
Saran-coated cellophane

C. World trends in plastic packaging

The total production of plastic materials in 1980 was about 200 million tonnes out of a crude-oil production of 4 billion tonnes.

The figures for plastic packaging were:

Region or country	Production (Thousand tonnes)	Production (Percentage)
Western Europe	20 897	35.5
Eastern Europe	7 289	12.3
Asia (without Japan)	2 560	4.3
Japan	7 518	12.8
North and South America (without the United States)	2 996	5.1
United States of America	16 079	27.3
Africa	880	1.5
Australia	772	1.2
Total	58 991	100.0

The development of the world market in plastic packaging may be forecast as follows:

	1980	1995	Annual rate of growth (%)
Per-capita consumption (kilogrammes)	13.4	22.5	3.5
Total consumption (thousand tonnes)	58 782	128 300	5.3

	1980	1995	Annual rate of growth (%)
Total production (thousand tonnes)	58 991	131 300	5.3
Production of thermoplastics (thousand tonnes)	47 384	107 880	5.6
Polyethylene	17 125	41 530	6.1
LDPE	(12 012)	(25 935)	5.3
HDPE	(5 113)	(15 595)	7.7
Polypropylene	4 833	13 500	7.1
PVC	11 152	22 380	4.8
Polystyrene	5 634	13 825	6.2
Others	8 640	16 645	4.5

Some of these figures should be corrected because, since 1980, new types of polyolefins have come onto the market, such as linear low-density polyethylene, and in our opinion the growth of HDPE will not be so important as expected.

Also, due to the increasing cost of packaging and still more to the improvement of the mechanical strength of films, the tendency is now to reduce the thickness of these films. This reduces, of course, the weight consumed for the same surface. The rate of growth in surface is therefore, likely to be higher than that in weight.

It does not seem likely that many new polymers, unknown [illegible] will appear in the near future for use in packaging. One reason [illegible] continuing need to reduce the cost of packaging. A new packaging material will be viable only if it can be produced on a very large scale, or if the packaging has the feedback of another industrial application (as is the case with polyester film), or if the material can be easily used by the end users with their present packaging process, on the existing packaging machines. No new product, even if it has marvellous properties, has any chance of success if its price is too high and if it could not be run normally on the existing packaging machinery. We already have all the basic plastic materials which we will need in the near future and they are approaching a production volume sufficient to keep the price as low as possible. There will only be a possibility or probability of development in a plastic material if its energy cost is low to start with and its machinability would be easy to increase.

Various trends can be distinguished in the development of plastic packaging materials.

Oriented polypropylene (OPP)

This is the most dramatic development of recent times. The growth of OPP film during the last years was 14 per cent a year. The OPP share of the packaging market has now stabilized at 10 per cent in spite of the economic crisis.

This is a case of a material which has taken a long time, maybe 10 years, to develop and to attain a good machinability. This length of research and development can only be justified if the price is certain to remain low.

Polyester

Over some years, polyester film (polyethylene glycol terephtalate) has been increasingly introduced in composite packaging (laminates). Polyester film was not initially produced for packaging but for industrial end uses. It was a very sophisticated film, made with perfect accuracy, for magnetic tapes (audio, computer, video) for insulation, for capacitors and for graphic art. Year after year, as demand increased, the volume of production and production capacity also increased and price decreased correspondingly. This industry needed to sell that part of its production which was not suitable for the most demanding end uses. The packaging industry was happy to receive the feedback of this production surplus at a price per square metre which is among the lowest of the films generally used in packaging.

Consumption of polyester films in converted packaging is increasing and will increase further. It is the strongest film, even in a very thin gauge (12 micron), and it is heat-resistant up to 200°C.

Polyamid film

Another film launched in recent years is the bi-axially oriented polyamid film (nylon). In contrast to polyester, this film is only made for converted packaging, it is used mainly to package coffee because of its puncture-resistant properties. But there are few producers, the energy cost is high and the volume of production is therefore not great.

Suiting the film to the packaging machine

The end users will increasingly equip themselves with automatic packaging machines in order to reduce costs through increased productivity and better efficiency in packaging. These machines run faster and require a greater accuracy and higher quality in the film they use. The film must have good flatness, good and quick sealability and good slipping properties.

This means a continuation of the trend towards strong diversification of the new generation of materials into specific types where each property is more or less emphasized. This is particularly true in the case of the polyolefin family.

In the development of laminate materials, polyethylene is used in rolls. When the polyethylene roll is unwinding on the laminating machine, it must be perfectly flat with a very good regularity of gauge obtained by a good extrusion process including rotary dies, control of cool-air blowing, tension regulation at the winding roller and so on.

In the production of laminates, it is very important to chose the right kind of film for the type of packaging machinery used. For instance, some machines need a very good slipping property in the film, others need quick sealability or a quick-cooling sealant. In each case, it is necessary to have a different type of polyethylene base film in the laminate. These types of polyethylene are differentiated by accurate density within the LDPE family, by content of slipping additives, by molecular weight and by the copolymer component (EVA).

Coating

More and more converters are using coating on their products mainly in order to improve the barrier properties of the basic material. These coatings are generally aqueous dispersions of polymers: polyvinylidene chloride, polyvinyl alcohol.

Bi-oriented extrusion

This process is increasingly used for the extrusion of bottles in rigid PVC as it improves the bottle's strength. Bottles made by this process can be used for sparkling waters.

Metallized film

There has already been a large development in the technology of vacuum metallization with an increased capacity to produce this type of film everywhere. In general, it is polyester film and also increasingly OPP film which is metallized. These metallized films must be laminated to protect the aluminium side.

The appearance of these films is excellent and their oxygen transmission is the lowest that can be found in flexible packaging. In laminates, it has many advantages over aluminium foil and it is not more expensive. It is used in a wide range of coffee and food packaging.

General trends

In general, the tendency for the end user is to want to reduce the cost of the packaging without loosing any of its performance. The relation of price to performance is the guideline of the end user. This is the reason why he tries to avoid using the extremely sophisticated packaging that the converters would like him to use.

Another tendency is to use a lot of single film or laminate for all purposes, based on a large volume of production. Examples are OPP film and laminated OPP/LDPE. This is the cheapest solution. On the other hand, there is also a tendency to develop specialized materials to package sensitive products requiring special treatment, such as sterilization, for example, or to give extended shelf-life.

II. THE PLASTIC PACKAGING INDUSTRY IN MEXICO

A. Production and consumption of cellophane compared to that of oriented polypropylene (OPP)

The markets for cellophane and for OPP, and the applications of these two products, are exactly the same, except in some very rare cases. The transfer from cellophane to OPP film has become relatively easy although it is more difficult to convert OPP and to use it on the older generation of packaging machines.

Converters and users who have a very long experience with cellophane are not very keen to switch to OPP film, but the difference of price per surface area between the two materials has become so great in favour of OPP that they are likely to accept some technical constraints, especially as the price differential will increase.

There are two producers of cellophane in Mexico:

	Approximate production capacity (tonnes per year)
CYDSA	15 000
CELMEX	7 000
Total	2 000

The main raw material for cellophane is wood pulp and most of the requirement for this is supplied within the country. Linters or fibres of cotton are also used. A small part of the wood pulp needed is imported and other raw materials used such as caustic soda and carbon disulphide must be imported at present.

The consumption of cellophane is around 10,000 tonnes per year, or 50 per cent of the production capacity. The forecast in 1980 that predicted an increase in consumption of 8 per cent a year till 1985 was mistaken, because on the contrary consumption has decreased steadily by about 10 per cent a year since 1980, to the benefit of OPP.

A substantial production capacity for OPP film has already been installed in Mexico. Four companies are involved:

	Production capacity (tonnes per year)	Number of machines
CELMEX	4 000	1
Polycel	5 000	1 (not yet in production)
CYDSA	10 000	3
Nova Pack	3 500	1
Total capacity	22 500	

An additional capacity of 4,000 tonnes is expected to be operational at CELMEX in 1989.

The capacity utilization is again about 50 per cent, with the market consuming 11,000 tonnes of OPP films per annum, equivalent to a consumption of cellophane of 18,000 tonnes (due to the difference in density).

Without OPP, the market for cellophane would be 10,000 + 18,000 = 28,000 tonnes. We can say that the market for cellophane and OPP together has been growing by 8 per cent per annum since 1980. This means that the growth of OPP film could be 8 per cent plus 10,000 tonnes taken over from cellophane in the next five years. So we could expect a growth of about 15 per cent per annum for OPP in the next five years, if the import of raw materials remains free and if we assume that cellophane will disappear by 1990. These forecasts are in accordance with what has been happening in industrialized countries.

However, cellophane producers do not seem pessimistic. They estimate that reinforced cellulose structures such as thin-gauge, saran-coated cellophane will remain very popular with converters. Cellophane also has the benefit of being favoured by the public authorities since it is entirely a local product whereas Mexico does not produce the polypropylene needed for OPP film. The production of cellophane is at 50 per cent of its capacity because competition from OPP is reducing its market, whereas OPP is at 50 per cent of its capacity because it is still in the midst of its launching period. Probably the lack of raw material is also a brake on its development.

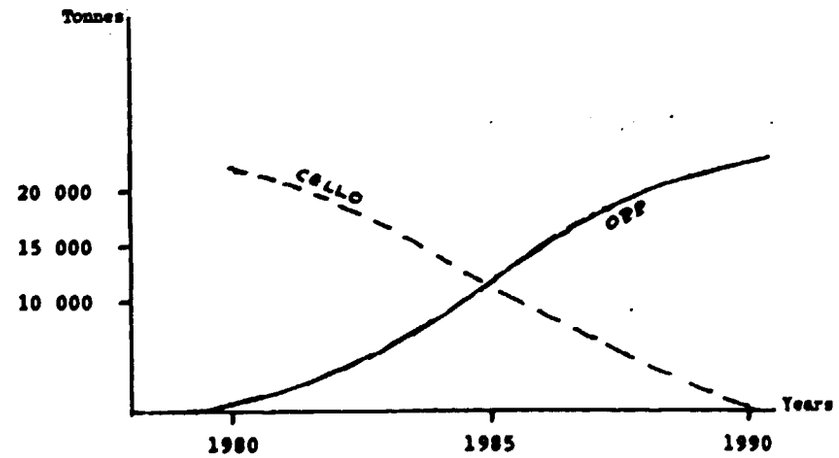
It is obvious that, in the medium term, cellophane is bound to decrease since the interest of the end users in reducing their packaging costs is bound to prevail. The adaptation of OPP film to packaging machinery is also improving. For example, CELMEX uses the know-how of the Wolff company (Federal Republic of Germany) which has an excellent process of copolymer extrusion coating on OPP film. This process provides a low-threshold sealing temperature which is the most important problem in heat-sealing OPP.

There is already a sufficient production capacity for the consumption of OPP forecast for the next years, but, as mentioned above, a growth of 15 per cent a year in a free-import situation can be expected. The estimated consumption would be:

	Tonnes
1984	11 000
1985	12 000
1986	14 500
1987	16 800
1988	19 200
1989	22 000

This would mean that capacity must be increased in 1988. By this time, cellophane will probably be nearly phased out. Consumption figures are presented graphically in figure I.

Figure I. Consumption and forecast consumption of cellophane and OPP up to 1990



The expected market growth for cellophane and OPP together is 8 per cent per annum from 1985 to 1990.

B. Production and consumption of low-density polyethylene (LDPE)

The apparent total consumption of LDPE has been:

	Tonnes
1975	105 000
1976	108 000
1977	136 000
1978	158 000
1979	132 000
1980	195 000

In 1980, the forecast for the next five years was:

	Tonnes
1981	208 000
1982	235 000
1983	251 000
1984	278 000
1985	308 000

This means a growth rate of about 10 per cent a year.

Packaging accounts for 77 per cent of the total consumption of LDPE. This means that packaging in LDPE will be 237,000 tonnes in 1985.

At the same time, the national capacity to produce LDPE resin has remained stable at a level of 99,000 tonnes.

In 1982, PEMEX, which has the monopoly of petrochemical products, produced 93,000 tonnes of LDPE, an almost total capacity utilization.

The balance of consumption has to be supplied by imports, and the volume of these will obviously increase so long as the production capacity stays stable. In 1985, it will be necessary to import more than 200,000 tonnes of LDPE.

There are two main uses for LDPE in the packaging field:

(a) In commodity bags and pouches for all purposes where a particular quality or raw material is not specified. If the bag is weak for any reason, the thickness is increased. This application is the most important by volume;

(b) In lamination and all specialized packaging where different types of LDPE film or resins are specified for different needs and where quality must be accurate and constant. This is an important but smaller section of the market.

In the first type of use, there are not really any problems. If the quality of the raw material were to be improved in terms of regularity or melt index, the producers of films would not need to increase the thickness of film to avoid weakness due to irregularity in the resin and could save some money. On the other hand, these producers would only have to improve their own

technology and their equipment to achieve a better regularity and perfect flatness in the film. They could achieve this by using rotary dies to even out the variations in thickness of the film, by careful control of the cooling of the balloon with ventilators, and by controlling the tension at the winding roller.

It is the second type of use that is the most important growth point of the industry in developing new types of flexible packaging. In these applications, polyolefins are always one or more of the elements of the packaging and the quality of these polyolefins is so crucial that they need a special production.

The national producer (PEMEX) has proposed the production of some types of resins but the customers do not seem satisfied with the variety of types proposed, nor confident of their quality. In every case, converters need to have:

(a) An accurately specified density since this in turn influences the temperature of heat sealing, the stiffness and the transparency;

(b) An accurately specified ratio of slipping agent;

(c) A perfect definition of melt index (molecular weight).

It appears at present that such co-operation and communication between the producer of resin and the converters does not exist. The converters have to use whatever PEMEX produces or imports and cannot do otherwise.

C. Production and consumption of high-density polyethylene (HDPE)

Mexico started production of HDPE in 1978 and installed capacity is around 100,000 tonnes. Consumption has recently been 120,000 tonnes including imports of about 40,000 tonnes.

Flexible packaging does not use much HDPE because it is not easy to seal and it is too stiff. However, it is successfully used in bags in the supermarket and a promising new use has appeared with the development of the co-extrusion process in which HDPE is co-extruded with LDPE. At present, flexible packaging accounts for only 5 per cent (6,000 tonnes) of the total consumption of HDPE.

The most important end uses for HDPE are:

(a) Tanks and containers made by the rotary moulding process;

(b) Bottles made by injection or extrusion blow moulding.

As far as the future is concerned, it is necessary to be cautious since the development of the new linear low-density polyethylene, which has some of the same properties as HDPE, could slow down use of the latter.

D. Consumption of polypropylene

The consumption of polypropylene in Mexico was 76,000 tonnes in 1982. The consumption forecast for 1985 is 90,000 tonnes, showing a growth rate of 8 per cent per year. Mexico does not yet produce any polypropylene in spite of an installed capacity of 215,000 tonnes and a projected capacity of 434,000 tonnes.

The likely developments of polypropylene in packaging are:

(a) In the packaging of textiles with cast film because cast polypropylene is more transparent than polyethylene and also stiffer;

(b) In lamination, cast polypropylene will be used in the cases where a higher heat resistance is needed, i.e. for sterilization in pouches;

(c) In co-extrusion with LDPE.

However, most of the future of polypropylene resin lies in the production of OPP which is already launched on the Mexican market and, as has been seen, is expected to have a consumption level of around 20,000 tonnes in the medium term. Today, the OPP film produced in Mexico is used as a single film for all purposes and end uses, like cellophane film, or in lamination with LDPE.

In injection blow moulding for bottles, cast polypropylene will be used more and more because it is easier to convert than HDPE, it has a better fat resistance and it is stiff enough.

Figure II gives the consumption and forecast consumption of polypropylene in Mexico. The values for 1981 and 1982 are atypical, those for 1981 probably reflecting an overstorage and those for 1982 showing the effect of the economic austerity plan. The underlying trend, representing an average of the 1981 and 1982 figures, is shown by the dotted line.

E. Production and consumption of polyvinyl chloride (PVC)

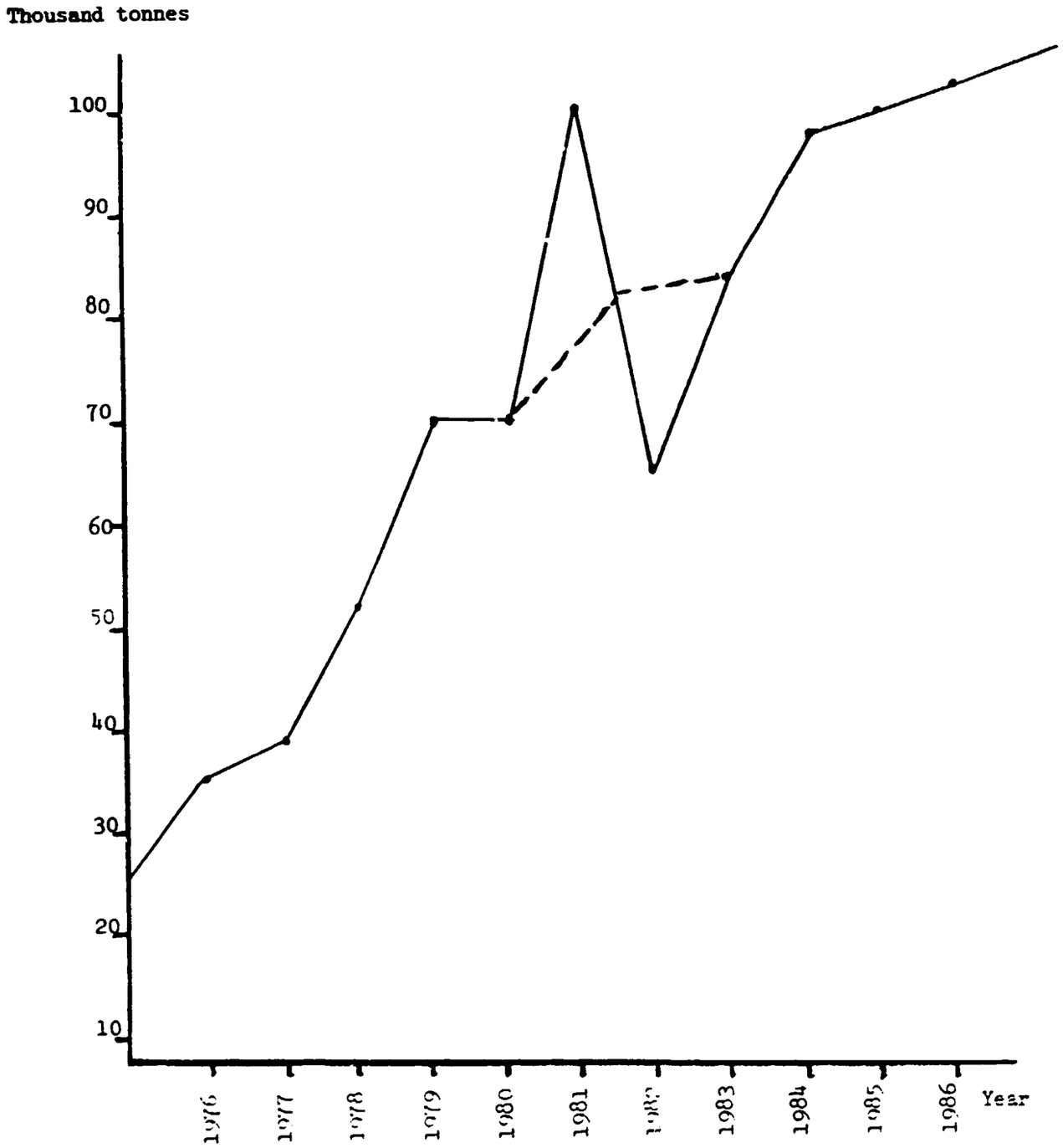
The installed capacity for the production of PVC resin is 286,000 tonnes a year (246,000 tonnes of suspension polymerized resin, 30,000 tonnes of bulk polymerized resin and 10,000 tonnes of emulsion polymerized resin). Actual production is around 140,000 tonnes per annum, or about 50 per cent of capacity. Production is divided between five producers who buy the vinyl chloride monomer from PEMEX and polymerize it in their 10 plants. The five producers are Polycid, Plasticos Omega, Industrias Resistol, Polimeros de Mexico, and Promociones Industriales Mexicanas.

Not much of the PVC production goes into the packaging industry (about 28 per cent of the total). About 14 per cent of PVC consumption is sheets and film. In this form, PVC can be used for overwrapping boxes because of its clarity and perfect dimensional stability. It is also used in twist wrapping for chocolates and candies where OPP is not appropriate. But the most important end use for thin PVC is in the hand-wrapping of meat, cheese and processed meats in supermarkets with stretch PVC film or sometimes with shrink film.

The thicker films or sheets, from 150 to 400 microns, are converted by a thermoforming process to give semi-rigid packaging for many products including butter, margarine and other fats. In this sort of application, PVC is in competition with polystyrene, and PVC only has an advantage where the product makes an oxygen-barrier, grease-resistant packaging necessary, which many dairy products such as yoghurt, cheese and butter do. In other cases, polystyrene is easier to thermoform, cheaper and lighter.

On the other hand, PVC is more and more used in pharmaceutical packaging for wafers, tablets and capsules in thermoformed trays closed with aluminium foil.

Figure II. Consumption and forecast consumption of polypropylene up to 1986



The future for PVC film in packaging is relatively limited, except for the special stretch film, because the sealing of PVC is not very strong, its melting point is low (about 65°C) and it is therefore difficult to convert. Its main future is likely to lie in thermoformed packaging for pharmaceuticals and fats.

Another 14 per cent of total PVC production goes into making PVC bottles by extrusion blow moulding and these are increasingly replacing glass bottles. This is probably the biggest growth area for PVC.

The producers of PVC are not happy with the quality control of the vinyl chloride monomer with which they are supplied.

F. Production of flexible converted packaging

The total capacity for converting flexible packaging in Mexico is around 82,000 tonnes.

The largest part of this installed capacity is in the hands of big companies, roughly divided up as follows:

Company	Percentage share of production
Grafo Regia	60
Polycel (CELMEX)	18
Celloprint	8
Nova Pack	8
Others (mainly small converters)	6

All the main companies have a very high level of technology, as high as the best converters in industrialized countries. The traditional processes used in the plants of these converters are:

Printing:	Rotogravure process. There are few machines using the flexographic process because customers prefer rotogravure printing.
Dry lamination:	With adhesive in solvent. Sometimes water-based adhesive as in paper/aluminium foil laminate.
Hot-melt coating:	With waxes or elastomers.
Extrusion lamination:	Extrusion of LDPE in a thin gauge between two layers of plain film, with or without adhesives.

Some plants also have:

Vacuum metallization:	On paper, OPP and cellophane.
Co-extrusion blow moulding:	For three layers on circular die.

It is obviously possible to produce all kinds of flexible packaging with this equipment.

The raw materials used by these big converters are sheets and films made of:

Cellophane
OPP and cast polypropylene
LDPE
HDPE
Nylon
Polyester
Paper
Aluminium foil

They also use resins for extrusion lamination such as:

LDPE
EVA (copolymer)

The laminates which are generally produced by these converters are:

Saran-coated cellophane + LDPE
OPP + LDPE
Cellophane + LDPE + aluminium foil + paper (by extrusion lamination)
Polyester + LDPE
Polyester + aluminium foil + LDPE
Nylon + LDPE
Paper + aluminium foil + LDPE

The main problems that the converters have are that:

(a) Their market is not growing fast enough due to the restrictions on consumption. For the same reason, likely end users refrain from making new investments in packaging equipment;

(b) The quality of their raw materials is not good enough either in the films or in the resins. The sophisticated equipment they have requires film with a perfect regularity of gauge, flatness, melting point and so on;

(c) It is difficult to import specific films or resins not produced in the country, such as polyester, surlyn and EVA;

(d) Such imports are very costly;

(e) They are not satisfied with the correct and accurate specification of polyethylene resins and think that what they receive does not correspond to their specific order.

In view of this situation and particularly of the restricted market, the tendency of the large converters would be to go more and more towards sophisticated, special-purpose packaging to increase added value. One possible danger in this situation is that customers have to buy more elaborate packaging than they need. A solution is to have more small converters producing simpler and cheaper packaging with a sufficient level of performance.

G. Forecast consumption of plastics in packaging in 1985

It is very difficult to get an accurate idea of the actual consumption of plastics in packaging in Mexico, because the latest statistics available are from 1980 and the forecasts at that time have proved absolutely inaccurate due

to the distortion of consumption in the years 1981 and 1982 and the effect of the economic policy of 1982. Consequently, the following values for consumption of plastics in packaging are approximate.

Type of material	Forecast consumption 198[illegible] Mexico ('000 tonnes)	Mexico (%)	World (%)	Expected annual growth Mexico (%)	World (%)
LDPE	200	52	25	5	6
HDPE	40	10	11	6	5
Polypropylene	70	18	10	7	10
PVC	50	13	23	4	6
Polystyrene	15	4	12	2	5
Cellophane	10	3	-	-8	-12
Others	1	-	19	50	8
Total	386	100	100		

The per-capita consumption of plastic packaging in Mexico in 1985 is estimated as 5.4 kilogrammes compared to 13.0 kilogrammes in the world as a whole.

III. VISITS TO RAW-MATERIAL PRODUCERS AND CONVERTERS

The expert made visits to various companies from which the following information is derived.

A. Polietileno National de Mexico

This company makes films of low-density polyethylene using an extrusion blow moulding process, prints the film and converts it into bags and pouches. The equipment consists of:

14 extrusion machines, small and medium size
8 bag machines
3 printing machines, four-colour flexographic process

Three of the extrusion machines can print the film in line.

The total production is 400 tonnes per month.

The raw materials used are mainly LDPE and a very small quantity of HDPE. All the polyethylene resins come from PEMEX without technical data sheets giving the specifications of the resin. The quality-control manager is not warned of variations in the type of LDPE (grade, density, slipping additives), although these can cause problems of quality. The resins do not have good regularity and consistent quality. The film is often sticky and bags are not easy to open.

The equipment of this plant is not really up to date. They have no rotary die which could even out the variations of thickness in the film which are very large (± 10% in surface, and 25% from point to point).

Cooling of the balloon does not exist. The waste pieces, which are around 10 per cent, are sent to another company that pounds and regranulates them, which is certainly more expensive than if this company did it themselves.

This company's market is mainly in bags and pouches for commercial users and pre-cut rolls. This market does not require a very high quality product but it is obvious that the present quality is insufficient in the case of rolls of bags, mainly due to the low-quality resin and the obsolete equipment.

B. Celloprint

This company produces laminates of different kinds and other flexible packaging materials in printed rolls. The processes used are extrusion lamination with flexographic and rotogravure printing (making their own cylinders). Their equipment consists of:

1 flexographic press, central drum, six-colour (rarely used)

3 rotogravure printing machines, four-, six- and eight-colour

2 old rotogravure machines, six- and three-colour (out of service)

1 dry lamination machine (800 mm) with hot-melt coating equipment

2 machines for extrusion lamination, with equipment for primer coating

1 very up-to-date machine for extrusion lamination with computer (width 1,200 mm, double corona treatment)

15 slitting machines

Equipment for designing and engraving photogravure cylinders

The raw materials and the quantity of each used by Celloprint are:

	Tonnes per month	
Cellophane	90	
OPP	5	
LDPE (films and resins)	120	
Paper	50	
Aluminium foil	60	
Total	325	(about 3,800 tonnes per year)

Celloprint use a small quantity of imported polyester and surlyn.

The main laminates produced by Celloprint are:

Cellophane + LDPE
OPP + LDPE
Cellophane + aluminium foil + LDPE

In the extrusion lamination process, 12-micron LDPE is extruded at 350°C between the two films for bonding, one of them is coated with a primer, ADCOTE M76. The LDPE resin used for the extrusion comes from PEMEX or is imported from Dow Chemicals in the United States of America. The extrusion lamination sometimes uses polypropylene resin as the firm has some stock of Tenite from Kodak.

Cellophane is still largely used by Celloprint for flexible packaging and OPP has not really taken its place in lamination, even though the price is 30 per cent lower, because it is not so easy to convert. The dryer temperature must be limited and the flatness of the OPP film is open to criticism.

Celloprint also uses a small quantity of polyester (Mylar) from DuPont, (United States of America). The OPP films used by Celloprint are co-extruded. The aluminium foil (9 micron) is laminated in Mexico by the firm Alcan who import aluminium.

The market for converted packaging went down in 1982 by 4 per cent, but in 1983 it grew again by 1 per cent. Celloprint say that they have 39 per cent of the market for flexible packaging. This is likely to be an exaggeration since, as will be seen, Grafo Regia, another converter visited by the expert, claims to have 70 per cent of the market, also an overstatement.

However, Celloprint is a large converter and its equipment is very good, with performance and capacities not at present fully utilized. For example, the Rotomec printing machine runs at a speed of 90 metres per minute when this machine can normally run at 120 metres per minute.

The dry lamination process could be developed further.

C. Rotoplas

This company makes tanks and large-capacity containers in HDPE. These are intended for the storage or transportation of chemical products, liquids for the pharmaceutical and food industries, and water storage on the roof of buildings.

The process used is rotational moulding in which the mould is filled with the necessary quantity of HDPE powder, then closed, heated up and turned in the two directions without pressure. When the mould is cool, it is opened up and the moulded piece extracted. The cycle is one hour. This process is the cheapest of the moulding processes. The cost of the mould itself is only $5,000.

The raw material, HDPE, is completely imported, mainly from DuPont, Canada, who supply detailed specifications of the properties of their product, unlike the local supplier, PEMEX.

Rotoplas are not satisfied with the quality of the locally-produced material especially as the risks involved in the end use of their products, i.e. storage of chemicals, make absolute reliability of quality essential. No slightest weakness in their tanks and containers can be tolerated.

On the other hand, the process involved in importing the raw material is very complicated from the administrative point of view and many times Rotoplas has had a shortage of HDPE.

The price of HDPE is 150 pesos per kilogramme whether it is local or imported. The firm's consumption is 15 tonnes per month.

This market is growing due to the low cost and the great usefulness of these tanks and containers. Many end users are switching from steel or fibreglass tanks to plastic ones.

The director of the company informed the expert that an association of plastics converters now exists to represent the interests of the converters more powerfully to suppliers such as PEMEX and to the public authorities.

D. Celanese Mexicana (CELMEX)

This company is mainly concerned with the processing of chemical products and polymers, with the production of synthetic textile fibres and lately with flexible packaging. The flexible packaging is produced by a CELMEX subsidiary, Polycel, which used to be strongly integrated into the main company but now has more independence as CELMEX expect to sell their own films to other converters. Polycel took advantage of this to invest in an OPP production machine.

CELMEX produce regenerated cellulose film (cellophane). They are the second largest producer of cellophane in Mexico, with a capacity of 7,000 tonnes per year. CELMEX expect to remain in the market with cellophane as long as possible and in any case to maintain their market share with OPP film. Their policy with regard to cellophane is to reduce the thicknesses of film from 35 to 33 and 28 grammes per square metre for use in laminates and to promote the use of saran-coated cellophane film.

CELMEX produce OPP film with a copolymer extrusion coating patented by Wolff (Federal Republic of Germany). The production capacity of the Wolff machine is 4,000 tonnes per year. The company is seeking authority for an investment in a new 4,000-tonne machine which would be in production in 1989.

CELMEX also produce polyamid resins for fibres and make films with nylon 6. This is extruded cast film used for lamination with LDPE to make flexible packaging for processed meat. The firm expects to make an oriented nylon film in the future.

CELMEX produce the polyester resin (polyethylene terephtalate) for textile fibres, but they do not expect to make oriented polyester film in the future. It requires too expensive an investment for such a limited market, even with the many industrial end uses such as in magnetic tapes, graphic art and insulation.

However, CELMEX are going to supply their polyester resins for the production of extrusion blow moulded bottles, but this application is just in the launching stage.

Polycel estimate that the total national production capacity for converted flexible packaging is around 82,000 tonnes per year and that their share in this is 18-19 per cent.

E. Grafo Regia (Monterrey)

This company is integrated in the Visa group and produces flexible packaging. Another company in the group, Famosa, is concerned with the fabrication of cans.

The origin of the packaging activities in Grafo Regia was the production of labels for beer bottles. Today, they are certainly the largest converter of flexible packaging in Mexico. There are five departments concerned with design and engraving of cylinders, lamination, printing, production of film, and finishing.

Grafo Regia produce all kinds of laminates with paper, aluminium foil, cellophane, OPP, polyethylene, polypropylene, surlyn, EVA, nylon and polyester.

The processes used are:

Dry lamination
Coating
Extrusion lamination
Hot-melt coating
Co-extrusion
Vacuum metallization

In the finishing department, they have an embossing process and they produce tops for beer bottles.

They are also licensed to use the French process, Doypack, for producing "stand-up" pouches and they have the equipment for this.

Their converting equipment is very impressive:

4 dry-lamination presses
9 printing machines

2 extrusion-lamination machines
1 vacuum metallization machine
1 offset printing machine for paper
1 co-extrusion machine
A lot of other machines such as hot-melt coaters, slitting machines, embossing machines, and so on

The types of co-extruded film are:

HDPE + LDPE
HDPE + EVA
HDPE + surlyn

The company think that cellophane will continue to be used because their customers still have old packaging machines that do not accept the OPP film. They import polyester with great difficulty and are looking for a European supplier.

They also use polyvinyl alcohol (aqueous dispersion) to give an oxygen-barrier coating.

Grafo Regia can certainly make all possible kinds of flexible packaging. They can use and process all the varieties of raw material to be found on the international market. They could specialize in solving all the more difficult packaging problems but the risk in this is to become involved in producing more sophisticated packaging than the market needs.

F. Polycid

This company belongs to the group CYDSA. It produces only PVC raw material and has two plants, in Tampico and Mexico City. It polymerizes the vinyl chloride monomer which it gets from PEMEX by the processes of bulk, suspension and dispersion polymerization for homopolymers. It also makes the copolymer aceto-chloride for records.

The production at Polycid is 72,000 tonnes per year, mainly in suspension resin.

Polycid is connected with the firm G. Goodrich (United States) whose specifications for vinyl chloride monomer are more stringent than those of PEMEX. Polycid complain about the quality of monomer from PEMEX.

IV. SUITABILITY OF PACKAGING FOR DIFFERENT FOOD PRODUCTS

The different plastic packaging materials have various properties which make them more or less suitable for different foodstuffs. For example:

(a) LDPE is not compatible with oil and fats as it has a very high permeability to oxygen. Therefore fats and all other products which have any sensibility to oxidation should not normally be packed in LDPE;

(b) HDPE is better in this respect but the oxygen transmission is still too high. It is a mistake to package oil in a HDPE bottle;

(c) OPP has a good fat resistance, but high gas permeability.

With this sort of consideration in mind, this chapter gives recommended types of packaging for different kinds of food products. The right kind of packaging has to be used for the protection of the food packaged.

Type of food product	Recommended packaging
Edible oils	Only PVC bottles are suitable. All polyolefin solutions (HDPE blown containers) must be rejected.
Confectionary	Pouches of OPP film (30 µ), on vertical form-fill-seal machines, or OPP/OPP sandwich-printed laminate. Twist wrap for candies: thin gauge PVC (25 µ), metallized PVC, metallized cellophane, or cast polypropylene.
Biscuits	OPP single film (30 µ), OPP/OPP sandwich-printed laminate, saran-coated cellophane. Much surface printing to avoid discoloration of biscuits.
Bread	Shrink PVC, perforated polyethylene.
Meat	Stretch PVC on cardboard plate. For big pieces of meat in wholesale trade, laminate bags of Polyamid/LDPE.
Processed meat	Vacuum packaging: laminated saran-coated cellophane/LDPE, nylon/LDPE, polyester/LDPE, cellophane/aluminium foil/LDPE.
Noodles	OPP single film (30 or 35 µ) or laminated OPP/LDPE.
Potato chips	OPP and metallized OPP (35 µ), or saran-coated cellophane bags on vertical form-fill-seal machines. No laminate with LDPE in contact with chips.

Snacks	Laminates: saran-coated cellophane/LDPE, polyester/LDPE, oriented polyamid/LDPE, metallized OPP/LDPE (vacuum packaging).
Nuts	Laminates: as above.
Coffee	Vacuum packaging: Laminated oriented polyamid/LDPE, Laminated polyamid/LDPE, Laminated polyester/LDPE, metallized oriented polyamid/LDPE, metallized polyester/LDPE.
Mineral water	PVC blow-moulded bottles only.
Vinegar	HDPE blow-moulded bottles.
Rice	LDPE bags on vertical form-fill-seal machines.
Salt	LDPE bags on vertical form-fill-seal machines.
Spices	Laminates: saran-coated cellophane/LDPE, oriented polyamid or polyester/LDPE.
Dry vegetables	LDPE bags.
Fresh vegetables	Perforated LDPE or HDPE bags.
Margarine	Thermoformed PVC, or aluminium foil/paper (not polystyrene).
Butter	(as above)
Liquid milk	LDPE or HDPE extrusion blow-moulded bottles. produced in the plant where the milk is prepared. This is also the cheapest solution.
Dried milk	Laminates: metallized OPP/LDPE, metallized polyester/LDPE, LDPE bags in cardboard boxes.
Olives, gherkins	Laminates: OPP/LDPE, polyester/aluminium foil/LDPE.

V. PACKAGING MACHINES

There are a lot of different packaging machines in the world, but most of them are divided into three categories:

(a) Vertical form-fill-seal machines;

(b) Horizontal form-fill-seal machines;

(c) Overwrapping machines.

Vertical form-fill-seal machines

These machines are generally not very fast. The average speed is 45 to 50 packets per minute. The pre-weighed product drops by gravity feed into the pouch that has just been made and whose sealing is not yet cool. The last side is then heat-sealed. The threshold sealing temperature of the film must not be too low. In the case of LDPE, the very low densities under 0.922 should be avoided.

On these machines, there are large steel surfaces in contact with the film. This means that the film must have good slipping properties and not stick to the sealer jaw.

Horizontal form-fill-seal machines

These are generally very fast machines, running at 140 to 180 packets per minute. The dwell time at the heating bar is very short and in this case the threshold sealing temperature of the film must be the lowest possible. Even at low temperatures, there is always a risk of the film adhering to the machine and, as the film is in contact with a long steel surface, its slipping properties must be excellent. At the same time, it must be strong enough to support the weight of the product.

These machines always make a longitudinal fin seal, i.e. two edges of the same side of the film are sealed together at the seam of the pouch.

Overwrapping

These machines either directly wrap the product placed on a preform, or overwrap boxed products such as biscuits and cigarettes. These machines are not very fast, except for those that wrap cigarettes. They need film of a very good flatness, non-curling and with a good slip.

Most of these machines were made to use regenerated cellulose film (cellophane), and they cannot always be used easily with the new OPP film. The OPP film must be sealed at 130-140°C and the sealing jaw must not be heated over 160°C since at this temperature the film shrinks and melts. The threshold temperature is about 100°C. The margin of temperature control is very narrow and the regulation must be accurate to within plus or minus 2°C. With cellophane, the sealing can be done at any temperature from 120°C up to 200°C.

The plastic films also have a greater or lesser static electricity charge, which it is possible to limit by antistatic additives, but some machines have also to be equipped with non-conductive bars.

The Mexican producers of packaging machines have to pre-plan these modifications on their equipment and for this they need to maintain very good communications with the producers of film and the end users.

VI. DETAILED RECOMMENDATIONS

1. The production capacity for low-density polyethylene (LDPE) should be increased

This is generally recognized as the first priority in the development of plastics in Mexico. In a situation where Mexico produces so much crude oil (the basic material of LDPE) and where the country has to import at least half the LDPE which it uses, there is every good reason to aim at self-sufficiency in producing this plastic.

LDPE is the most frequently used material in plastic packaging and demand for it is likely to grow faster than for others. The cost of transportation of the resin is high in relation to the cost of the product and also the international price of LDPE is subject to fluctuations according to the surplus or shortage of stocks. It is feared that import restrictions may be introduced in the near future and it is essential to develop new production capacity to supply the domestic converting firms with the LDPE they need.

2. The quality control of polyethylene resins should be improved and accurate specifications given for the types of resins appropriate to each kind of end use

The converters are generally not satisfied with the quality and the regularity of the resin that they receive from PEMEX. If specifications are supplied, they are not sufficiently detailed and converters do not know if they are accurate. The following different types of resin would certainly be needed in the packaging industry:

(a) LDPE, density 0.917, grade 4, for extrusion lamination, extrusion coating, and all laminates used on horizontal form-fill-seal machines;

(b) LDPE, density 0.922, grade 4, for dry lamination to give transparency;

(c) LDPE, density 0.920, grade 0.7, for single film, bags and pouches;

(d) MDPE, 0.930, grade 2.0, for lamination with heat resistance over 100°C;

(e) Copolymer EVA (4% of vinyl acetate) for easy heat sealing, and for lamination with OPP.

It would be a great advantage if all these types of resin could be produced in Mexico.

3. The quality of low-density polyethylene (LDPE) films for lamination should be improved

There is a big difference between the film produced for single bags and pouches and that produced in rolls of flat film for lamination. In the first case, the quality and regularity of film is not a top priority, but in the second case, the quality and the speed of the lamination process depend on the perfect flatness of the film. Irregularity of thickness must not exceed 10 per cent from one point to another and 5 per cent in grammes per square metre.

The equipment for extruding these types of LDPE must be more sophisticated than others in terms of controlled cooling of the balloon and correct mixing on the die.

The recycling of wastes must be done by the same converting plant in order to be sure that it is the same type of resin.

4. Polypropylene resin should be produced in Mexico

Polypropylene is the polymer whose use is likely to grow fastest in the near future. There are no reasons why the cost of producing polypropylene should be higher than that of LDPE. In the steam-cracking process, polypropylene is produced along with the large quantity of ethylene which is needed and the amount of polypropylene so produced is probably in excess of present requirements. The development of OPP film will require more and more imported resin. At present, the production of OPP film is about 10,000 tonnes a year and it will probably grow to 20,000 tonnes a year in the next five years as it replaces cellophane. Mexico has enough production capacity for oriented polypropylene film for the next five years.

In injection blow-moulded bottles, polypropylene will be increasingly used instead of low- and high-density polyethylene, because although polypropylene suffers from poor resistance at temperatures below 0°C, this is not a problem in the climate of Mexico.

The types of OPP film that would be produced are:

(a) Non-heat-sealable film, base films in 20 microns or 0.8 microns;

(b) Heat-sealable film produced by co-extrusion (25, 30 and 35 microns) or as coating (1, 1.2 and 1.4 microns).

5. The production of simple and cheap packaging by the smaller, local converting firms should be encouraged

There is certainly a need for relatively simple packaging which could easily be produced by the smaller converters using single OPP film printed with a flexographic process. It is said that customers prefer rotogravure printing and this is probably true for a certain level of customer and for important orders. But for smaller customers with limited orders, the flexographic process is much cheaper and the delivery time shorter. Of course, big converters tend to promote rotogravure printing because they have the equipment for this. It should not be forgotten, however, that in the United States of America, 50 per cent of packaging printing is done by flexographic process.

As in all countries, there is a market here which is not best served by the big converters with sophisticated packaging, but by smaller local firms who can offer good and fast service, good communication, and reasonable quality at reasonable prices.

It is advisable to give help of a technical nature, advice on material properties and performance, machinery and so on, to these smaller converters to help them remain viable in the face of competition from larger firms.

Such advice could be given by the Laboratorios Nacionales de Fomento Industrial (LANFI) (the National Laboratories for Industrial Promotion).

6. It is desirable to introduce production of PVC bottles in the plants which produce the liquid which they will contain

The production of extrusion blow moulded bottles in special plants is relatively expensive. It involves transportation of the empty bottles (a big volume although a light weight) to the filling plant and the need to wash the bottles before filling to make certain that the insides have not become polluted during transportation.

To install a bottle-making machine in the plant which produces the liquid is not so great an investment. Its operation is easy and the bottles which are made can be immediately forwarded to the filling point, thus guaranteeing the sterility of the inside.

This would be an especially good idea for the producers of edible oils and mineral waters.

7. The production of vacuum-metallized films should be encouraged

In many cases, these could replace aluminium foil, thus reducing imports of aluminium. Cellophane, OPP, polyester and polyamid are the base films which can be metallized. The capacity to metallize already exists in Mexico.

8. The production of oriented nylon film for use in laminates should be promoted

OPP does not have the same advantages that cellophane has as a base for laminates with polyolefins. This is due to the limited heat resistance of OPP (no more than 140°C where that of cellophane is over 200°C).

The laminate OPP/LDPE, which is currently produced, needs a very low threshold sealing temperature and mostly a very accurate range of sealing temperature.

In countries where cellophane is disappearing, OPP film can take the place of it for single film packaging, but for laminates, it is polyester or oriented nylon which are now generally used. In these countries, these two films are also cheaper per square inch than cellophane.

It has already been mentioned that polyester, which would be the best support film in laminates, is not expected to be produced in Mexico in the near future due to the cost of investment.

In view of this, the best alternative for the short-to-medium term is to promote the production of oriented polyamid film which Mexico is in a good position to do. The resin is produced in Mexico and cast nylon is also being produced. The cost of investment is not very great, but it would be necessary to acquire a patent from the Japanese firms, KOJHIN (AMILON) or UNITICA (EMBLEN).

9. Some improvements should be made in the various technological processes used

Improvements would include:

(a) Improving the technology of extrusion blown polyethylene by using rotary dies, and improving cooling and tension control;

(b) Keeping up with the development of solventless laminating technology and equipment;

(c) Improving the quality of flexographic printing among the small converters, including good stereo quality;

(d) Improving the quality of printing inks and avoiding the use of toluol solvent.

10. The use of co-extrusion technology for packaging should be promoted

The big converting plants already have very good equipment for co-extrusion. In the expert's opinion, there will be a big demand for this type of packaging. For example, HDPE co-extruded with very low-density polyethylene or even better with EVA can be used on vertical form-fill-seal machines with heat sealing rather than with impulse sealing. This is a cheap solution for all-purpose packaging.

Given that Mexico produces polyamid, a second important possibility with this technology might be the co-extrusion of polyamid and low-density polyethylene which should have very good oxygen-barrier properties.

11. More information and technical assistance should be made available to the end users

It would be desireable that LANFI should be more involved in giving technical advice to the end users in the food industries in order to help them in the choice of the right packaging materials and packaging machines. End users should as far as possible be brought together for information conferences and seminars to increase their knowledge of the properties of all the plastic materials on the market and the types of packaging machines and the suitability of the one to the other. This would promote the installation of automatic packaging systems, which increase the output of plants, and, if the right materials and machinery are chosen, improve the protection of the food product being packaged. The end user needs a source of advice and information which is independent of the suppliers of packaging materials and machinery.

Annex

JOB DESCRIPTION

(DP/MEX/82/010/11-53/31.7.E.)

Post title: Consultant in the production of plastic packaging

Duration: One month.

Date required: As soon as possible.

Duty station: Mexico City, with travel within the country.

Purpose of project: To assist the Government in the definition of a national packaging consumption and manufacture policy; in the elaboration of integrated guidelines, regulations and incentives for the development of the packaging-manufacture industries, according to the main national needs and priorities; and in the rationalization for economic-planning purposes of the packaging machinery used in the country.

Duties: The consultant will be assigned to SECOFIN (Ministry of Commerce and Industrial Promotion) and will report to the Director General of Food and Consumer Goods Industries or the delegates thereof if so determined and be introduced to the national counterpart(s) for the mission. The consultant will specifically be expected to:

1. Get acquainted with the existing study on the short and medium term forecast for the consumption of packaging in the country, as well as with the reports of former experts who have recently carried out missions related to the technical field of the present one;

2. Get acquainted with the main principles and priorities of the Government's economic policy and analyse their influence or effect on the utilization and manufacture of plastic packages in the country;

3. Visit some important plastic and laminated-package user and manufacturer industries, to evaluate and discuss the present conjuncture of plastic packaging in the country and define the main parameters which have a definitive influence on the country's self-sufficiency in plastic and laminated packages;

4. Elaborate and propose a programme of technical, economic and legal measures for the promotion and guidance of the development of the country's plastic and laminated-package manufacturer industry in the light of the Government's economic policy;

5. Give ad hoc advice on matters within the technical field of the mission whenever specifically requested by the national counterparts.

The consultant will also be expected to prepare a final report setting out the findings of the mission and recommendations to the Government on further action which might be taken.

Qualifications: Plastic packaging technologist with a university degree or equivalent experience and specific capacity with regard to techno-economic studies and industrial planning.

Language: English (Spanish an asset).

Background information: The on-going project "Research and Development in Food Processing and Packaging Technology" was submitted for a thorough revision in the light of the related priorities within the present Government programme, namely: effective substitution of imports, elimination of non-indispensable imports, consolidation of an export industrial capacity, development of technology in the priority sectors and rationalization of the production activity.

The revised project is aimed at providing the Government with basic working elements and specialized advice for the elaboration of an appropriate policy for the development of the packaging industries in the light of the actual economic conjuncture of the country.