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PROBLEMS IN TRANSFER OF PLASTICS TECHNOLOGY TO DEVELOPING COUNTRIES[1/]

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Contents

The transfer of plastics technology to developing countries is effectuated through licensing agreements. Depending on the volume of a process and the properties of a product the licensing agreement has to enable and regulate the transfer in regard to technological, economical and legal aspects.

A licensing agreement in the field of a petrochemical production of plastics might be more difficult to establish than in the field of plastics processing. However, in each case the agreement has to cover all relevant facts concerning process know-how, engineering data, guarantees, quality control, delivery time, mounting, start up of the plant, instruction of personal, payment conditions, risks, services, patents and other rights.

The transfer of plastics technology to a developing country is not principally different to the transfer in a developed country. It can happen, that a developing country has a higher petrochemical development as a country, which is considered as economically developed. In regard to petrochemical production Austria can be regarded at the time being before the realization of the petrochemical projects in construction as underdeveloped, compared to developing countries as f.i. Mexico and Puerto Rico.

For this the transfer of plastics technology as it has been effectuated in the past to and from Austria may be of interest to developing countries; it will be discussed and evaluated in the following.

1.0) Austrian Plastics Technology

Austria started its development in the field of plastics after the second world war. The invention of urea-formaldehyde resins was done by Fritz Pollak in this country in the early twenties. Based on production plants for phenol and urea-formaldehyde resins compression moulding was the first step in plastics processing technology. Compression moulding machinery has been developed at this time and the hand injection moulding process for thermoplastics has been effectuated in Austria before world war II.

The plastics consumption has grown in Austria from 1 kg per capita in 1953 to more than 20 kg in these days. Considering a population of 6 to 7 million persons it has grown from 6,000 t per year to more than 150,000 tons of plastics materials and articles in 15 years.

Contrary to a normal assumption for developing countries the influence of the existing petrochemical resources as crude oil and natural gas in our country to our petrochemical production of plastics was very insignificant. Considering an Austrian crude oil production of 2.5 mill tons per year and a natural gas production of 1.5 bill m^3 the Austrian production of plastics raw materials is only to 20% based on petrochemistry at this time.

1.1) Thermoplastics Production

1.1.2) Polyvinylchloride

After some tentative experiments for PVC-production - immediately after the war in Upper Austria - which have not been successful, in the early fifties a PVC-plant has been erected in Hallein near Salzburg as a joint venture of SOLVAY, ICI and the bankers CREDITANSTALT BANKVEREIN. The process is based on the reaction of acetylene and hydrochloric acid and the plant has been stepwise enlarged in the following years, according to the growing Austrian PVC consumption. Besides suspension polymerization products, emulsion polymerisates in different grades are available.

1.1.3) Polypropylene

Following the MONTECATINI process a plant for the production of 5,000 tons isotactic polypropylene was erected in 1961 near the Schwechat refinery, which provides propylene gas at a maximum capacity of 20,000 tons.

Due to the fact, that polypropylene was at this time a rather new plastics raw material, many years of experience in plastics processing have been necessary to develop a sufficient consumption on the Austrian market, which is now characterized by selling the actual production of 12,000 tons. Propylene as invention of Prof. NATTA was for the first time available in 1956 and in the first years of production only an amount of 700 tons could be sold on the home market. The Austrian experience confirmed the general rule, that a period of ten years is necessary between the appearance of a plastic material on the market and the integration in the processing industry. The same period of time was needed for the introduction of polyethylene and polystyrene to the market after their appearance in the early thirties. It might be of interest, that no polypropylene production exists at this time in developing countries. However, the experiences gained in the production field and by industrial applications could now justify the transfer of polypropylene technology to developing countries at optimal production rates of 20,000 tons per year.

1.1.4) Other Polymerization Plants

For polymerization plants, based on imported liquid monomers, the transfer to Austria has been effectuated for polyvinylacetate, following the HOECHST process and for polymethylmethacrylate according to the ROSTERO process, each in the range of several thousand tons production per year.

However, both plants are relatively compact and it seems, that the building up of such a relatively independent polymerization unit could easily be effectuated in a developing country, if the necessary conditions of market, capital and labour are given as well as the technological background in regard to material and utility supplies.

For some years around 1963 existed in Austria a plant for the polymerization of foam-grade polystyrene out of imported styrene. For reasons of profitability the plant is no more on stream. At the time being a relatively big production of polystyrene foam exists in Austria, based on imported foam-grade polystyrene. The importers of this material have exclusive contracts with owners of polystyrene foam machinery and are able to serve their market shares.

Today all other thermoplastic raw materials as polyethylene, polystyrene, copolymers etc. besides all synthetic rubbers are imported. In the field of synthetic fibers we have only one production: a polyesterfiber-plant, based on the imported monomer (dimethylterephthalate).

1.2) Thermosetting Resins Production

As mentioned before productions for phenol and urea and lately for melamine-formaldehyde resins are in existance for quite some time. A new process for melamine production has been developed by ÖSW and a transfer of technology to developing countries under licensing conditions could be achieved.

Urea-formaldehyde resins are very important for applications in Austria because of its richness of wood. Besides applications for glueing wood furniture and panels the production of particleboards (Spanplatten) since 1953 (according to a Swiss invention) - under the application of heat (180°C) and pressure (150 atm) - consumes several thousand tons of urea-formaldehyde resins.

Four plants are producing polyester resins according to own processes and licensing agreements with foreign licensers (BAYER, REICHHOLD, BAKER).

No transfer of technology to Austria exists in the field of epoxies. They are imported besides other thermosetting resin compositions for applications in containers, for coating etc.

1.3) Petrochemical Conception

By reviewing the petrochemical planning and development in Austria during the last 12 years the result of several decisions, which have taken place during this time, can be evaluated. The relatively slow development of the polypropylene production was retarding other potential planning.

It might be of interest, that at the same time, as the polypropylene plant was erected, the plans for building up a polyethylene plant have been developed so far that a territory in the neighbourhood of the Schwechat refinery has been purchased for this purpose; later on due to the falling tendency of petrochemical prices the project has been cancelled. It is clear, that the Austrian petrochemical production of plastics would be more developed today, if the polyethylene plant in connexion with an ethylene plant would have been on stream since the early sixties. Probably a backward integration of the existing monomer polymerization plants and the rising of a petrochemical complex connected to the Schwechat refinery (4 million tons throughput) would have been possible.

Due to the fact, that of all existing plastics raw material productions only the polypropylene plant is based on petrochemistry, the amount of petrochemicals to the plastics production was not very significant in the last years. Adding to the actual production volume of this plant the production figures for formaldehyde (as one petrochemical component of the thermosetting resin production) approx. 20% of the total Austrian plastics production are belonging to this source. Formaldehyde production in Austria is effectuated on the base of methanol, which is synthesized by converting natural gas.

DANUBIA OLEFINWERKE Ges.m.b.H., a joint venture of BASF and ÖSW, decided last year to build up a plant for the production of 70,000 tons low density polyethylene. With this plant, which is expected to go on stream next year, the petrochemical base of our plastics production will reach the European level of the industrially developed countries. The fact, that the ethylene plant in construction has a capacity of 140,000 tons necessitates the planning of new petrochemical productions. Besides these plans at PETROCHEMIE AG Schwechat, an oxosynthesis plant and a phthalic acid plant are in construction.

1.4) Transfer of Plastics Processing

In the field of plastics processing a case study for the transfer of technology of a production line for building elements to developing countries shall be given.

1.4.1) Process Know-How

The product consists of a polystyrene foam core, bilaterally laminated with covering layers such as PVC, aluminium, chip board or asbestos cement.

PVC-polystyrene foam and PVC-sandwich elements are processed into:

Doors

Decoration Panels

Ceiling Elements.

Production, i.e. bonding of the top skin with the rigid foam core and the inserts as well as the foaming of the polystyrene between the layers in one single process is done according to the high-frequency process developed by the ANGER Company, Vienna.

1.4.2) Process Engineering

Consists of several steps:

Preparation of the PVC material and transportation to the extruder

Production of PVC sheet and profile

Adhesive spraying equipment

Pre-foaming station for obtaining the specific weight of the foam

High-frequency heating of PVC in presses for bonding with inner layer

Finishing of the elements.

1.4.3) Machinery and Equipment

1 Discharging device for sacks
2 Silo
3 Container, capacity for one day's operation
4 Container for master batch
5 Weighing device
5a Metering device for liquid additives
6 Mixer combination
7 Twin screw extruder
8 Twin screw extruder
9 Wide spread die
10 Smoothing, embossing and laminating calander
11 Forming device
12 Sheet take-off
13 Cross cutting unit
14 Sheet stacking carriage
15 Twin screw extruder
16 Profile die
17 Vacuum calibration
18 Profile take-off
19 Automatic saw with tipping truff
20 Automatic pre-foaming device
21 Silo with metering and conveying device
22 Mixer
23 Polystyrene spraying machine
24 Adhesive spraying machine
25 Mounting table and conveying device
26 Foaming station
27 Automatic stacking unit
28 Stacking carriage

1.4.4) Staff Requirements

	Number	Shifts	Total	Characteristics
Material preparation	2	1	2	semi-skilled workers
Sheet production	3	3	9	3 skilled workers (fitters) 6 unskilled workers
Profile production	2	1	2	1 skilled worker 1 unskilled worker
Pre-foaming	1	3	3	skilled workers
Foaming	8	3	24	3 qualified workers 21 semi-skilled workers
Finishing	5	1	5	semi-skilled workers
Stocking and final mounting	6	1	6	1 skilled worker 5 semi-skilled workers
Transport and various duties	2	3	6	semi-skilled workers
Fitters, electricians	1	3	3	
Total			60	

1.4.5) Power Requirements

	Electric Power	Compressed Air		Water		Steam/Fuel Oil	
		6 atm	10 atm	softened	norm.	10 atm	
	KW/h	m^3/h	m^3/h	m^3/h	m^3/h	kg/h	kg/h
Material preparation	106	1.5			3.0		
Sheet production	114	19.0		1.0	3.0		
Profile production	35	4.0		1.0	2.0		
Pre-foaming	10	20.0		0.2		80	
Foaming	250	20.0			10.0	70	15
Finishing	78		20				
Total	593	64.5	20	2.2	18.0	150	15

1.4.c) <u>Calculation Documentation</u>

<u>Investments</u> for the installation of an ANCER plant for the production of 1[illegible],000 APM doors per year, i.e. 260,000 m^2 APM sandwich panels per year (partition walls, wall coverings, suspended ceilings). This calculation plan is to serve the buyer as basis for the preliminary rentability calculation of an APM plant.

<u>Plant</u>

Machinery inclusive licence

Miscellaneous secondary costs

Secondary building costs (power distribution, office equipment, internal transport, test laboratory etc.) approx. 15% of the machinery

Freight and insurance approx. 5% of machinery

Customs duties, compensation tax

Mounting as per contract to be separately concluded

approx. DM 100,000.00

Miscellaneous approx. DM 100,000.00

<u>Buildings</u>

Workshops approx. 1,000 m^2 incl. stocking facilities and administration, approx. 20,000 m^3 building volume

Various secondary costs approx. 10,000 m^2 building site

Costs of opening up (power supply, water, waste water, road, parking)

<u>Gross calculation</u> for the production of 1[illegible],000 APM doors per year, finishing for mounting of the fittings. To simplify matters, only one product has been considered: a white APM door of the most popular size of 7 x 16 (DIN 18101) leaf size 860 x 1985.

The use of the free third shift (capacity approx. 140,000 m^2 per year) in the forming station, which has not been considered in the calculation, and which becomes possible by using additionally purchased covering material, i.e. the production of APM doors with wood decoration, would increase net proceeds considerably.

Calculation is based on ex works price; wholesale prices (or prices in case of direct sale to the ultimate buyer) are by 20 to 30% higher; the resulting gross price of doors meets market requirements.

Net proceeds

130,000 doors

Expenditure

Raw materials: 4.0 kgs PVC mixture
2.75 kgs Styropor P
0.5 kgs adhesive
5.75 kgs frame

Material overhead costs 5%

Costs of production:
Wages 60 workers 4 [illegible],000 h
Power
3 million kWh
100,000 m^3 water
Miscellaneous (fuels)
Maintenance

Other production costs

Extraordinary costs: Royalty DM 1.00/door to be paid
to [illegible]
Waste

Calculatory costs
Depreciation
Interests

Administration and sales
Packing

Turnover tax

Summary

Raw material

Production costs

Calculatory costs

Administration and Sales

Turnover tax

Production costs

Proceeds

Untaxed profits

Revolving capital

Production costs minus royalty, depreciation and
turnover tax

1.4.7) <u>Secondary Building Costs</u> (to be borne by the buyer)

For the installation of a plant for the fabrication of APW building elements according to the process described, the following facilities are necessary:

<u>Description of buildings and installation</u>.

1.4.8) <u>Products</u>

Single or double-shell sandwich panels with rigid PVC surface and rigid foam core may be produced in sizes up to 1,000 x 3,000 mm (3 ft. 3 in. x 10 ft.) and can be treated further, both manually and machine-wise. To this end, the tools customarily employed in plastics treatment are required.

Surface design: finely embossed; unicolour printed; structured; unicolour printed structured.

Sheet thickness: 20 - 120 mm (3/4 in. to 4 3/4 in.)

The foam density can be varied according to the individual applications.

In special panel types, the use of filled foam formulations is possible, in which cases wood chips, plastic scrap or asbestos cement scraps may serve as filler material.

Application: as filling or cladding sheets for ceiling and walls, for trade fair or exhibition construction, interior furnishing and decoration (furniture panels).

In the case of sandwich panels in the above mentioned dimensions, the following materials may be employed as an alternative to rigid PVC surfacing sheets:

Laminated plastic sheets on a phenolic-resin, melamine-resin or polyester-resin base.

Surfacing layers in wood materials such as layered or non-layered chipboard or moulded fiber board.

Sheets of inorganic materials e.g. asbestos cement sheets, metal sheets or ceramic sheets.

1.4.9) <u>Terms of Payment and Delivery</u>

<u>Prices</u>:

Ex works [illegible], unpacked, customs duties unpaid. Transport insurance from works [illegible] to destination are to be borne by the customer.

Terms of payment:

1/3 on order

1/3 in the middle of the agreed delivery time

1/3 on acceptance of the plant

Delivery:

8 - 10 months from date of order.

Mounting and starting of the plant will be controlled by ANGER staff. The costs of sending the staff to the place of mounting are included in the above prices. A separate contract has to be concluded on these services in due time.

1.5) Economic and Legal Aspects of Transfer of Technology to Developing Countries

As it is generally difficult to provide capital in developing countries, foreign investments or joint ventures are often the base of petrochemical enterprises.

Capital can be provided by the transfer from industrially developed countries, as f.i. the OECD countries.

As a general rule the amount of the aid for developing countries has been determined at the UNCTAD 1968 conference in New Delhi to 1% of the GDP of the participating countries. In 1967 the aid for developing countries amounted to 11 billions of dollars, of which the OECD countries contributed 88.4%, international organizations 8.6% and Eastern countries 3%.

Switzerland's aid is characterized by the fact, that nearly only private resources have been adopted. However, even in Switzerland the private investor gets from the state the guarantee for his investment.

Development aid has started 20 years ago and many multinational enterprises have been erected in the meantime all over the world. By 1975 it is expected, that the development aid of the OECD countries will amount to approx. 20 billion dollars. The modern version of the multinational enterprise can be regarded not only from the standpoint of common guidance and strategy, but also from the common use of an international pool of technical, financial and managerial resources.

Besides public aid, private financial aid amounts to approx. 40% of the investments. For joining the efforts by the application of private financial aid the APPI (Association Internationale pour la Promotion et la Protection des Investissements Privés en Territoires Etrangers) was founded in 1958 with headquarters in Geneva. The APPI is convinced that an increased international flow of private foreign investments can be promoted by the conclusion of a multilateral convention, based on strict reciprocity of generally accepted principles of conduct towards foreign property.

In this regard in 1967 a resolution was accepted by the OECD council, by which OECD member governments reaffirmed their adherence to the following principles of international law:

> The right to fair, equitable and non-discriminating treatment;
>
> The observance of undertakings made by states;
>
> The carrying out of direct or indirect expropriations is justified only if conducted with due process of law, against the payment without undue delay of effective compensation representing the genuine value of the property effected.

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