



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

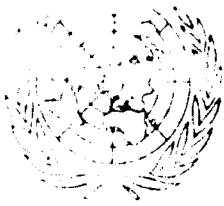
FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

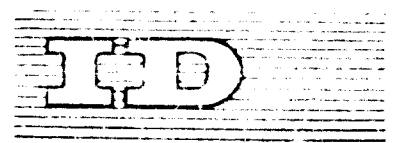
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org



D00253



United Nations Industrial Development Organization

Distribution
LIMITED

ID/WG.34/6
23 July 1969

ORIGINAL: ENGLISH

International Petrochemical Symposium on the
Development of the Petrochemical Industry in
Developing Countries

PET.SYMP. A/4

USSR, 20 - 31 October 1969

21

DEVELOPMENT OF PLASTICS FROM CHEMICALS

I. THE COUNTRIES OF THE COMECON

AND IN YUGOSLAVIA^{1/}

by

J. Mueller
Brno
Czechoslovakia

The views and opinions expressed in this paper are those of the author
and do not necessarily reflect the views of the secretariat of UNIDO.
This document has been reproduced without formal editing.

ID/WG.34/6

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

	Page
1. Contents	
2. List of tables	3
3. Introduction	5
4. The position of the COMECON countries as well as of Yugoslavia in respect of characteristic features of the world plastics and synthetic resins industries	6
raw material sources for the development of the petrochemical industry in the COMECON countries and Yugoslavia	10
5. Plastics and synthetic resins industries in the membership COMECON countries and in Yugoslavia	15
6.1 Albanian People's Republic	15
6.2 Bulgarian People's Republic	15
6.3 Czechoslovak Socialist Republic	16
6.4 German Democratic Republic	18
6.5 Hungarian People's Republic	21
6.6 Polish People's Republic	24
6.7 The Socialist Republic of Romania	27
6.8 The Union of the Soviet Socialist Republics	29
6.9 Federative Socialist Republic of Yugoslavia	32
7. Exports and imports of plastics and synthetic resins in the COMECON countries and Yugoslavia	35
8. Tables	38



Distribution
LIMITED

1. Copy to UNIDO
23 July 1969

ORIGINAL: ITALY

PER. SYNT. 1/

United Nations Industrial Development Organization

Interregional Petrochemical Symposium on the
Development of the Petrochemical Industries
in Developing Countries

Baku, USSR, 20 - 31 October 1969

SUMMARY

DEVELOPMENT OF PLASTICS FROM PETROCHEMICALS IN THE COUNTRIES OF THE COMECON AND YUGOSLAVIA 1/

by

J. Müller

Research Institute of Macromolecular Chemistry
Brno, Czechoslovakia

The rapid growth in the plastics and synthetic resins industry since World War II is first stressed. In the Comecon countries, the thermosetting resins have received most attention but thermoplastics are now developing rapidly.

The shortage of petroleum fuels in the countries of Eastern Europe outside Russia and Rumania has meant substantial imports, largely by pipelines. The position of each country in this respect is described in detail.

In the next section the stage reached in each country in the production of plastics and particularly thermoplastics from petrochemical sources is described. The subjects covered include such figures as the actual production, the rate of growth, existing

1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

plants and new plants under construction or projected. For many countries the end uses are also discussed.

Import and export trade in plastics is next discussed and in a final section tables are given showing:

- 1) the total production of plastics and synthetic resins in the Comeco countries and Yugoslavia to 1968 and projected to 1970;
- 2) similar tables showing the production of ethylene, PVC, polyethylene and polystyrene;
- 3) production of aminoplastics and acetylene in the various countries for 1964-1968;
- 4) the production of propylene in the various countries from 1965 to 1968 and projected to 1970, 1975 and 1980.

2. List of Tables

- Table 1.** The share of plastics and synthetic resins in the COMECON countries and the U.S.S.R. on the world production in 1966-1967 (in per cent.).
- Table 2.** The production of plastics and synthetic resins per head in the COMECON countries and the U.S.S.R. in 1966-1967 (in kg.).
- Table 3.** The growth of the production of the main plastics and synthetic resins in the world average, in the U.S.S.R. and in the U.S.A. in 1958 and 1966.
- Table 4.** The production and the presumed trends of the main thermoplastics in the COMECON countries as a whole (in thousands of metric tons).
- Table 5.** The total output of crude oil and natural gas in the COMECON countries and Yugoslavia in 1967.
- Table 6.** The share of the main plastics and synthetic resins in the total production of Czechoslovakia (in per cent.).
- Table 7.** The production of thermosets in Czechoslovakia (in thousands metric tons).
- Table 8.** The percentage of investments in various branches of Hungarian chemical industry and its change in the last period.
- Table 9.** The development of the chemical industry of the U.S.S.R. in comparison with the total industry (in per cent. in comparison with the previous period).
- Table 10.** The number of workers in all the industry of the U.S.S.R. and in the branches of chemical industry (in thousands workers).
- Table 11.** The total production of plastics and synthetic resins in Yugoslavia (except polyvinylchloride).
- Table 12.** The structure of production of plastics and synthetic resins in Yugoslavia (in metric tons).
- Table 13.** The U.S.S.R. exports and imports of some plastics and synthetic resins.
- Table 14.** Poland's foreign trade of plastics in 1966.
- Table 15.** The import of the main thermoplastics to Hungary.
- Table 16.** The pattern of polystyrene imports to Hungary.
- Table 17.** The total production of plastics and synthetic resins in the COMECON countries and Yugoslavia.

- Table 18. The production of polyvinyl chloride in the COMECON countries and Yugoslavia
- Table 19. The production of polyethylene in the COMECON countries and Yugoslavia
- Table 20. The production of polystyrene in the COMECON countries and Yugoslavia
- Table 21. The production of semioplastics in the COMECON countries and Yugoslavia
- Table 22. The production of acetylene in the COMECON countries and Yugoslavia
- Table 23. The production of propylene in the COMECON countries and Yugoslavia
- Table 24. The production of ethylene in the COMECON countries and Yugoslavia

3. Introduction

This report is based on the published data about the development of the petrochemical industries and the industries of plastic and synthetic resins in the COMECON countries and in Yugoslavia.

Collection, choice and modification, if necessary, of the individual data was done in such a way, that the most of the data might represent values since the year 1963. We did not even exclude significant data from the period before the year 1963.

We divide individual data in tables in that way so that the given data might be comparable and available also for studies about other territorial entities.

In consideration of the way of publishing data of this kind in the COMECON countries it was very difficult to obtain some necessary data at all, respectively their most probable values in some other cases, because they were published in several different versions. In some cases we did not succeed in obtaining any data at all. Where there was a necessity of keeping the continuity the required data were estimated by qualified experts. All such cases were indicated.

We have nevertheless tried to write this report despite of being aware of the fact that this report might have some gaps. There was an effort to complete the picture of the conditions and of the development of the petrochemical industries and industries of plastic and synthetic resins in the above-mentioned geographical area.

A. The position of COMECON countries as well as of Yugoslavia in respect of characteristic features of the world plastics and synthetic resins industries.

In the period after World War II the consumption of plastics and synthetic resins increased enormously both in the production of consumer goods and in industrial use.

Plastics and synthetic resins considered at the beginning as a substitute for the traditional natural materials have now become for their very valuable technical properties materials the substitution of which is already unthinkable, especially if we take into consideration their much lower production costs.

The application of plastics and synthetic resins in many new fields resulted in a rapid growth of the world-wide scale requirements. The high and steady growing demand stimulated the development of the production of these materials, above all in highly industrialized countries, as in the U.S.A., Japan, the F.R.G., countries, Great Britain, the U.S.S.R. and some others.

Even if the world production of plastics and synthetic resins has already reached a relatively high level, it belongs to one of the most quickly developing industrial branches in the present decade. While the total world industrial output rose in 1966-1967 by 30 per cent, and the production of the chemical industry by 70 per cent, the output of plastics and synthetic resins increased in the same period 2 1/2 times and reached the record of 11 billion metric tons. A special attention should be paid to the rapid growth of thermoplastics. In 1966 and 1967 the growth of thermoplastics achieved 16 per cent and exceeded the growth of the chemical industry approximately two times.

The western countries hold an especially significant position in the world production of plastics and synthetic resins. The last year's production of these materials in the U.S.A. (4.7 mil. metric tons), in Japan (2.1 mil. metric tons), in the Federal Republic of Germany (2.0 mil. metric tons), in Italy (1.2 mil. metric tons), in Great Britain (1.1 mil. metric tons) and in France (0.9 mil. metric tons) represented over 80 per cent of the world production of these materials.

The rapid growth of the production of plastics and synthetic resins has continued also in the countries of Eastern Europe. In the years 1960-1967 this production increased much more than two times and achieved 1.3 mil. tons.

In Table 1 the share of the COMECON countries and that of the U.S.S.R. of the world production of plastics and synthetic resins in the years 1966 and 1967 is illustrated. In Table 2 the production of plastics and synthetic resins per head for the COMECON countries as a whole and for the U.S.S.R. particularly in 1966 and 1967 is given.

Table 1: The share of plastics and synthetic resins in the COMECON countries and in the U.S.S.R. on the world production in 1966 and 1967 (in per cent)

Country	1966	1967
COMECON	2.2	2.5
U.S.S.R.	5.2	5.3

Table 2: The production of plastics and synthetic resins per head in the COMECON countries and the U.S.S.R. in 1966 and 1967 (in kg.).

Country	1966	1967
COMECON	4.7	5.4
U.S.S.R.	3.9	4.2

The significance of the Tables 1 and 2 is limited to a certain extent with regard to the small time span. As, however, other relations not mentioned in this report evidently exist, we can deduce that the total share of plastics and synthetic resins production of the COMECON countries on the world production will increase rapidly and that it is and will be proportional to the share of the total industrial production in these countries.

The production of plastics and synthetic resins in the COMECON countries have a rather different pattern than the same production in western countries. It is the result of the requirements of manufacturing industry and of the subsequent passing on to the petrochemical basis. Thermoplasts have, up to now, both a great significance and a great share on the total production, while the production of thermoplastics, mainly polyolefins, is to develop essentially in near future.

The differences in the pattern of the particular plastics and synthetic resins and their growth are given in Table 3. The world average and the share of the production of the main plastics in the U.S.S.R., as the greatest country of the COMECON countries, and in the U.S.A., as the most developed western country, are compared.

Table 3: The growth of the production of the main plastics and synthetic resins in the world average in the U.S.S.R. and the U.S.A. in 1958 and 1962 (in per cent)

	World average		U.S.S.R.		U.S.A.	
	1958	1962	1958	1962	1958	1962
Polystyrene	11	17	2	5	16	16
Polyvinyl chloride	21	23	2	18	10	19
Polyolefins	11	16	2	7	19	27
Phenolics	26	22	50	42	18	15

Table 3 shows objectively a great share of thermoplasts in the U.S.S.R., but it shows the shifting the production to thermoplastics as well.

In Table 4 the recent productions and the presumed trends of the main thermoplastics in the COMECON countries are given which show the stress, which is set on the development of thermoplastics in these countries.

Table 4: The production and the presumed trends of the main thermoplastics in the COMECON countries as a whole (in thousands of metric tons).

	1955	1960	1965	1968	1970	1975
Polyvinyl chloride	50	120	260	-	-	-
Polyethylene h.d.	-	-	5	30	60	350
Polyethylene l.d.	1	1.5	30	220	450	1300
Polypropylene	-	-	4	30	70	220

Nothing indicates that the favourable prosperity of plastics and synthetic resins on the world market should decrease in any way. This demonstrates the expected rapid development of their consumption, which will surely be followed by a growth in production. According to the often repeated estimates the world production of plastics and synthetic resins will reach approximately 40 million metric tons in 1975 and thus will rise more than twice in comparison with the year 1955. The share of the West European countries should be nearly one quarter of the total world output.

The observers of the plastics and synthetic resins markets agree in the opinion, that thermoplastics have the best prospects. Above all polyethylene and polypropylene. Having increased from 2 percent to 56 percent in the last decade the share of this group is expected to reach nearly two thirds of the total world production of plastics and synthetic resins in the year 1975.

5 Sources of raw material the development of the petrochemical industry in the COMECON countries and Yugoslavia.

The availability of oil fuels in Eastern Europe with the exception of the U.S.S.R. and Roumania are considerably limited. Because of the steady growth of the fuel requirements for power engineering and of raw materials for the rapidly growing petrochemical industry the COMECON countries, in spite of their effort to increase their own output, import large quantities of crude oil from the U.S.S.R. using the pipe-line Bružac (Friendship).

The total production of 308.3 mil. metric tons in the COMECON countries in 1967 represents 17.3 per cent of the total world production of crude oil (Table 5).

Table 5: The total output of crude oil and natural gas in the COMECON countries and Yugoslavia in 1967.

	Crude Oil in Millions Metric Tons	Capacity of the refineries Millions Metric Tons per year	Natural Gas in Billions cub m
Albania	0.9	0.5	-
Bulgaria	0.7	3.0	0.02
Czechoslovakia	0.2	6.0	0.3
GDR	1.0	7.0	-
Hungary	1.7	4.7	1.6
Poland	0.4	4.0	1.4
Roumania	13.2	13.0	18.5
U.S.S.R.	233	235	138
Yugoslavia	2.5	4.3	0.6
Total	308.3	277.5	161.42

Albania Petrochemical Industry

Albania is the poorest country of COMECON. Its production of crude oil is very small, but with regard to its undeveloped petrochemical industry it exports

about 10 per cent of its production of crude oil. Two refineries are in operation, the larger one has the capacity of 300,000 metric tons/year. Albania processes now about 510,000 metric tons, but exploits 900,000 metric tons of crude oil. It plans to increase its own production to 1.2 millions metric tons in 1970.

With the assistance of the Chinese People's Republic the construction of the third refinery started which will process 1 million metric tons of crude oil per year.

The Albanian resources of natural gas estimated at 9 billions cbm are not exploited at present and their partial exploitation may be expected only in the future.

Bulgarian People's Republic.

The present Bulgarian output of crude oil is not extensive, but a substantial growth is planned in the near future due to the new fields found in the surroundings of Dolni Dabnik at Pleven. The estimated resources of this field are not quantitatively large, their capacity is estimated to 15-20 mil. metric tons, but the quality of crude oil is excellent and equal to that of American crude oil. On this new material basis a second petrochemical complex is being built which is to start with the production in the next year and to process about 1 mil. metric tons of crude oil from 10 oil wells.

At present there are three refineries in operation the capacity of which is about 3 millions metric tons per year. There is a project of increasing the capacity of the existing Burgas refinery to 5-6 mil. metric tons/year since 1970. This refinery belongs to the first Bulgarian crude oil complex and processes above all the Soviet crude oil imported in tank vessels across the Black Sea. There is also a project in existence which is to process 4 millions metric tons of crude oil/year.

The estimate of the resources of natural gas is 30 billions cbm. Although the total production of natural gas is insignificant nowadays there are some prospects that Bulgaria will be independent of imports.

Czechoslovak Socialist Republic.

The possibility of increasing its own production of crude oil and natural gas are negligible. Czechoslovakia possesses a well-developed petrochemical

industry and refineries, which process Soviet crude oil. 6.2 million metric tons of Soviet crude oil were imported through the pipe-line Družba (Friendship), that means 99.5 per cent of the required crude oil. This import is to increase in the next years.

The capacity of the Czechoslovak refineries is about 6 million metric tons/year. The largest Czechoslovak refinery Slovnaft at Bratislava is to increase its capacity by 2 million metric tons of crude oil per year.

German Democratic Republic.

German Democratic Republic processes above all imported crude oil. The geological exploration did not discover any larger sources of crude oil so far.

According to the agreement from the year 1965 the U. S. S. R. delivers 36 million metric tons of crude oil in 1966-1970, that is 95 per cent of the requirements on the import of crude oil.

The processing capacity of refineries amounted to 5.3 million metric tons in 1965, 6.6 million metric tons in 1966, 7 million metric tons in 1967 and it is to reach 10.4 million metric tons in 1970. The main petrochemical plants are in Schwedt (3 million metric tons in 1970) and in Leuna (3-4 million metric tons in 1970). The complex in Leuna is being erected and consists of two plants: Leuna I, which processes lignite and Leuna II, which processes Soviet crude oil.

Hungarian People's Republic.

Hungarian became an important producer of natural gas among COMECON countries and has good prospects in output. 1.5 billion cbm of natural gas per year are exploited in Hajdusoboszló. This represents about 94 per cent of the total output of the country. The estimate is that the output will amount to 3 billion cbm in 1970 and will increase to 4.7 billion cbm in 1975.

An increased production of crude oil of 2-2.5 million metric tons per year is expected because of the growing output in the oil fields east of the Danube at Szeged.

The Hungarian refinery industry possesses five refineries, three of them have been built before the Second World War. Their output reached 3.9 million

metric tons in 1965, at the beginning of this year 4.3 million metric tons (the actual capacity being 4.7 million metric tons per year). After the extension of the refinery in Szazhalombatta the annual output is to be increased to 6 million metric tons in 1970.

The Socialist Republic of Roumania

Roumania has one of the oldest crude oil industries in the world, which is still being extended due to the intensive geological exploration for which about 10 per cent of the total industrial investments is given.

Owing to the construction of new refineries with high capacities Roumania has a well-developed petrochemical industry which ought to be extended and modernized. The value of the basic products produced from 1 tons of crude oil rose almost by 50 per cent in 1967-1968.

With regard to the fact that the processing capacity of the refineries will be higher in the future than the output of crude oil and also considering the requirements of the developing petrochemical industry Roumania concluded some trade agreements with several Middle East countries in respect of the import of crude oil in exchange for oil drilling machines.

The Union of the Soviet Socialist Republics.

The output of crude oil in U.S.S.R. was 233 million metric tons in 1967 and is expected that of 300 million tons in 1968. The estimate is that the output will reach 345 million tons in 1970, 450-470 million metric tons in 1975 and will approach 600 million metric tons in 1980.

The output of natural gas was 37.5 billion cbm in 1966, 111 billion cbm in 1967 and 139 billion cbm in 1967. This year's output is estimated at 170 billion cbm and that of 570-700 billion cbm per year is expected in 1980.

Besides the extension of crude oil and natural gas production and the development of the processing industry U.S.S.R. has relevant problems with the transport of the above-mentioned products because of its geographic situation and exports to all COMECON countries. The pipelines are the cheapest way of crude oil and natural gas transport. The network of

pipelines and gaslines is therefore being expanded which makes possible both to improve the domestic supply and to ensure the growing export of these raw materials. The length of gaslines in U.S.S.R. reached 51,200 km in 1967. The second way of improving the transport of these raw materials is the construction of new pipelines in a large scale.

The Federative Socialist Republic of Yugoslavia.

Yugoslavia intends to increase its production of crude oil in the near future. At the beginning of the next year the production will start in new oil fields near the Hungarian frontier. The annual production of 250,000 metric tons of crude oil and 50 billion cbm of natural gas is estimated.

The present production of crude oil in Yugoslavia is less than 4 million metric tons per year and will reach 5.5 million metric tons in the next years. Yugoslavia is importing about 2 million metric tons/year because the capacity of refineries exceeds the production and is to attain 11-13 million tons/year in 1970.

The resources of natural gas, the production of which doubled from 335 billion cbm to 605 billion cbm are estimated to 47 billion cbm.

6. Plastics and synthetic resins industries in the membership COMECON countries and in Yugoslavia.

6.1 Albanian People's Republic.

No reports concerning the petrochemical industry in this country are available. According to the position of the industry in general it can not be assumed that this branch of industry is developing. Almost with certainty it can be asserted that the plastics and synthetic resins production is not developed, provided it exists at all. Albania retired from its membership in COMECON in September 1968.

6.2 Bulgarian People's Republic.

The chemical industry of Bulgaria is one of the most developing industrial branches. The volume of the chemical output is to increase approximately three times in the period 1965-1970. Within the chemical industry the petrochemical industry and the plastics industry will develop most rapidly, their production volumes are to increase approximately by 26 per cent this year.

These data give evidence of the high dynamics of the petrochemical industry and of the plastics and synthetic resins branches, but the share of plastics and synthetic resins given in units is very low. This production being about 10,000 metric tons in 1966 included mostly polyvinyl chloride and phenolics. The basis of the future development of this branch will be the petrochemical industry. In the chemical complex at Burgas the first unit for the production of low pressure polyethylene with a capacity of 10,000 metric tons per year was put into operation in 1966. In 1967 a polymerization unit of 24,000 tons/year of high pressure polyethylene licensed by the English concern ICI was put into operation. In the next years the production of polystyrene at a capacity of 10,000 tons/year will start in the above-mentioned complex. The unit for the production of synthetic resins with a capacity of 15,000 metric tons/year will also be established at Burgas. 10,000 metric tons of butadiene, 30,000 metric tons of isoprene and 5,000 metric tons of butadiene-styrene latex will be at the disposal by the year 1970.

Plants for the production of acrylonitrile and styrene are also projected. A unit for suspension polyvinyl chloride with a capacity

of 10,000 metric tons/year will be built in the plant K. Marx to the year 1970.

By realization of these projects the production of plastics and synthetic resins will reach 100,000 metric tons per year in 1970.

6.3 Czechoslovak Socialist Republic.

Conditions under which the modern chemical industry in Czechoslovakia was developing after the Second World War were not very favourable. As an industrial branch with great need of raw materials it suffered a chronic lack of modern materials. This situation supported in a certain period by the autarchy led to a deep imbalance within this branch. The Czechoslovak chemical industry missed above all more rapid orientation to the production of synthetic materials as synthetic rubbers, plastics, synthetic resins and synthetic fibres. For example since the building up of the first Czechoslovak semi-pilot plant of polyamide fibres in Planá nad Lužnicí in 1950 nearly 10 years elapsed before a new plant for polyamide fibres in Humenné in eastern Slovakia was put into operation. A similar situation was in the production of polyvinyl chloride in Nováky in Slovakia. The polyvinyl chloride production was not up-to-date to the requirements of the country as to quantity, quality and assortment. At that time the pattern of the plastics produced in the country was very poor and was limited to some classical and basic types. The thermosets production was three times greater than that of thermoplastics and this ratio is improving slowly in favour of thermoplastics (Table 6).

Table 6: The share of the main plastics and synthetic resins on the total production (per cent).

	1965	1970	1975
Polyvinyl chloride	21.2	18.3	28.5
Polyolefins	-	13.0	28.6
Polystyrene and copolymers	7.4	9.8	9.4
Phenolics	20.6	11.3	5.9
Aminoplastics	16.2	11.0	5.3
Others	34.6	36.6	22.3

A new orientation of plastics and synthetic resins industries was possible when passing on to petrochemical basis which reveals new possibilities of a rapid development of thermoplastics.

The plastics and synthetic resins consumption was about 10 kilos per head in 1965. In the year 1970 it should reach 14 kilos per head and according to optimistic estimates it should approach 25 kilos per head in 1975 and 30 kilos per head in 1980. In 1970 the total production of plastics and synthetic resins should be approximately 250,000 metric tons. A more significant change of the pattern in favour of thermoplastics should be reached only in the period after 1970.

Corresponding to the trend in other countries also in Czechoslovakia the main attention will be paid to the development of the production of polyvinyl chloride and copolymers, polyolefins and polystyrene and its copolymers.

The present raw material basis for the production of vinylchloride (carbide based acetylene) will be completely changed already in 1970 to the petrochemical basis. A new unit which should be put into operation in 1973 with the capacity 60,000 tons/year and should be oriented mainly to the production of vinyl chloride copolymers and chlorinated polyvinyl chloride.

A unit for the production of high pressure polyethylene with the capacity of 30,000 tons/year is in operation in the petrochemical complex Slovnaft in Bratislava in Slovakia. Within the next ten years two new polymerization units with approximately the same capacity should be established.

The products assortment is to widen to polyethylene copolymers mainly with vinyl monomers. Also a construction of a low pressure polyethylene unit is taken into consideration, but not before the year 1975. Its capacity should be about 30,000 tons/year.

The polypropylene production licensed by AVISOP-CHISSO with the capacity of 30,000 metric tons should be put into operation in 1971. The second unit with approximately the same capacity will be put into operation in 1975.

Polystyrene is produced in basic types and as to its further development it is essential to produce copolymers acrylonitrile-butadiene-styrene and copolymers styrene-methylmethacrylate.

Besides the thermoplastics already mentioned polymethylmethacrylate production, especially injection molding type and polyamide will be increased.

The extension of thermosets production is not taken into account, but the present production will be modernized.

The production of thermosets is in the following Table 7.

Table 7: The production of thermosets in Czechoslovakia (in thousands metric tons).

	1965	1970	1975
Phenolics	24.7	23.0	33.0
Aminoplastics	20.0	27.0	30.0

6.4 German Democratic Republic (DDR).

The chemical industry of DDR participates with approximately 3 per cent of the total world production of chemical industry. It ranks second among COMECON countries and seventh after U.S.A., U.S.S.R., Great Britain, German Federal Republic, Japan and France in the world. In the production of chemical products it is second in the world in per head production after U.S.A. and first among the Eastern Europe countries.

The industry in DDR increased 3.9 times and the chemical industry 4.2 times in 1950-1965. The annual growth rate increased by 10 per cent. It is much more than the annual average growth during the same period in the U.S.A. (7.4 per cent) or in Great Britain (5.2 per cent). The preferential development of the chemical industry will continue and will be accelerated when the raw materials basis shifts from a lignite basis to a petrochemical basis.

The growth of the petrochemical industry will be the determining factor of further development. 10 mil. metric tons/year of crude oil is to be processed in 1970 instead of 5.5 mil. metric tons of today, that means that about 110 mil. tons of lignite will be saved. Crude oil and natural gas will be imported by pipelines from the U.S.S.R.

At present 116.2 million cbm of natural gas are processed in German Democratic Republic. This is for some productions much more economical than crude oil. It is effective especially for the production of synthesis gases, carbon black and acetylene. Nevertheless till 1980 the traditional carbide chemistry will also be carried on and will be substantially improved so that its economic effectiveness will increase.

In the last years the development of chemistry in GDR was limited to the purchase of modern processes and complete production units from the western countries. For the future the production processes according to the processes elaborated in GDR or in co-operation with the U. S. S. R. and other members of the COMECON are taken into account.

Pyrolysis units with an annual production capacity of 200,000 metric tons of ethylene will be built according to processes from which a large output of by-products is available, namely propylene, butadiene and aromatic hydrocarbons.

The requirements of olefins and diolefins will be probably covered. To cover the needs of aromatics, above all of benzene, is a problem, which has not been solved up to this time.

Another source of the required petrochemical raw materials will be about 2 million metric tons of products from chemical processing of coal.

In the year 1965 216,000 metric tons of plastics and synthetic resins were produced in GDR. By this production this country ranked ninth in the world and seventh in Europe. In the year 1967 the total production of plastics and synthetic resins was 273,000 metric tons, of which about 41 per cent was polyvinyl chloride, 13 per cent polyethylene and about 3 per cent polystyrene.

In the year 1970 the production of plastics and synthetic resins is to increase to 400,000 metric tons, that means that the production on head should be 23.5 kilos. For the year 1980 the consumption per head about 50 kg. is planned. Development will continue mainly in the production of polyvinyl chloride, polyethylene, polystyrene, polyvinyl acetate and unsaturated polyesters. These plastics are based on carbide acetylene.

For extension of the production of vinyl chloride a substantial quantity of chlorine is still required.

The carbide basis can in no case provide for the planned development of plastics. In the year 1966 a change-over began with the construction of a new petrochemical complex Louny II. In the year 1967 the pyrolysis of petrol to give 40,000 metric tons of ethylene and the production of high pressure polyethylene licensed by the English concern ICI with a production capacity of 24,000 metric tons were put into operation.

The petrochemical share of the total production of plastics and synthetic resins is about 10 per cent today but by the year 1980 it should increase to 50 per cent.

In the second period of construction of the complex Louny II, the capacity for ethylene production will increase to 100,000 metric tons/year. A part of this production will be delivered to the work Chemische Werke Louny, where styrene and vinyl chloride will be produced by the combined acetylene-ethylene process. Propylene will be used for the production of cumene, phenol and acrylonitrile by the COHIO process.

As far as the pattern of plastics and synthetic resins is concerned about 70 per cent of the total production is thermoplastics. This corresponds approximately to the world relationship but the supremacy of polyvinyl chloride above the other thermoplastics does not correspond to these relationships. In the year 1966 the share of polyvinyl chloride in the total production of thermoplastics in the western countries was about 21 per cent, while in GDR it was approximately 45 per cent in the same year. This share meant already a substantial reduction because in the year 1963 the share of polyvinyl chloride production in the total production of thermoplastics was 53 per cent. This ratio is taken as very disadvantageous in GDR and ought to be modified by the intensive construction of new polyethylene units.

In the year 1967 after the construction of the complex Louny II has been finished the production of high pressure polyethylene reached 35,000 metric tons. 50,000 metric tons of the above-mentioned product should be produced according to a perspective plan in 1970 and there should be 25 per cent of the total production of plastics and synthetic resins in that year.

Low pressure polyethylene is not yet produced on a commercial scale, but a small unit is in the plant Chemische Werke Louny, which produces about 1,000

metric tons per year to cover the requirements of the plant. It is possible to produce also polypropylene on the same unit.

The construction of a polypropylene unit is not yet provided for and propylene will be used for the production of other chemical products.

The share of polystyrene was about 5-6 per cent of the total production of plastics and synthetic resins in last years. No outstanding increase of the production of polystyrene is planned.

In the years 1965 and 1966 about 90 per cent of the consumption of plastics and synthetic resins went for technical uses. The share of consumer goods is relatively small. The consumption of plastics and synthetic resins per head was about 11.2 kg. in 1965, about 12 kg. in 1966 and should be 23-24 kg. in 1970. The production per head was about 11.1 kg. in 1966.

GDR exports more thermoplastic than it imports. There is an effort to reduce the exports and to increase the imports. For example 29,000 metric tons of polyvinyl chloride was exported in 1965 and only 20,000 metric tons in 1966. The import of polyvinyl chloride, polyethylene and polyamide increased in 1966 in comparison with 1965 by 30 per cent. It is, however, necessary to realize that the total share of plastic and synthetic resins imports is negligible (about 2 per cent of consumption in 1965) and that only special types of plastics are imported.

6.3 Hungarian People's Republic.

In Hungary industrial production increased by 47 per cent in 1961-1965. At the same time the production of the chemical industry nearly doubled, so that the share of this branch in the whole industrial production reached 9.6 per cent.

Development of the chemical industry in the next five years is to be in the forefront of attention. The production of the chemical industry as a whole will increase by about 60 per cent in the period 1965-1970 and will be about 13 per cent of the whole industrial production in 1970.

The chemical industry must effectively contribute to enhancing the level of production and technology for the whole of industry, above all of synthetic materials, and help more effectively to satisfy the needs of the population, to improve the balance of foreign trade and to enable the increase in

agricultural production by production of fertilizers, plant protectives and other chemical materials.

The percentage of the investments in various branches of chemical industry and its changes in the last period are in Table 8.

Table 8: The percentage of investments in various branches of Hungarian chemical industry in the last period.

Period	Fertilizer Industry	Plastics Industry	Plastics processing Industry	Synthetic fibres Industry	Pharmaceutical Industry	Synthetic rubber Industry	Other branches
1961-1965	41.4	13.3	1.0	3.1	11.1	7.6	22.0
1966-1970	21.6	24.1	4.9	6.1	13.7	10.3	19.3

It may be stressed from the table that at present the expansion of investments in the plastics industry is stressed including plastic processing industry and pharmaceutical industry. At the same time the required development of fertilizers is supposed to be ensured above all by intensification of the present production.

The production of pharmaceutical industry is to increase by 50-55 per cent and reach 70 million florint in 1970. All preliminary conditions exist for developing this branch. The petrochemical industry is the most important branch for development of the chemical industry. Six million metric tons of crude oil and 3.0 billion cbm of natural gas are supposed to be processed in 1970. This will be the basis for an increase of organic chemistry. It is supposed that 5.6 per cent of the total production of hydrocarbons will be processed by the chemical industry in 1970. It is known that the hydrocarbons will account for one half of the raw material basis of the chemical industry.

A unit for thermal cracking of petrol with low octane number should be finished in the petrochemical complex Saschalembat in the year 1969. The output of ethylene should be polymerized to polyethylene (capacity of the polymerization unit 24,000 tons/year) and propylene will be processed to isopropylalcohol.

The production of acetylene by partial oxidation of hydrocarbons will be realized. On the same basis a plant for the production of polyvinyl chloride with a capacity of 30,000 tons/year will be established. At the same place production of aromatics on petrochemical basis will soon be put into operation. Two thirds of the needs of benzene should be covered from own production in 1970.

There are some prospects of building up another pyrolysis plant which would secure raw materials for plastics (polyethylene and polypropylene), acetic acid, ethylene oxide, ethylene glycol, dichloroethane and acrylonitrile. The production of plastics should triple by the year 1970 in comparison with the year 1965 and reach about 100,000 metric tons/year.

The share of thermoplastics will increase to 65 per cent of the whole production of plastics. Nevertheless it will still be necessary to import 40-50,000 metric tons of plastics which are supposed to be imported mostly from COMECON countries. Only polyurethanes and some types of polystyrene will be imported from Western countries.

In connexion with the planned increase of the plastics production the production of plasticizers chiefly for PVC based on octylalcohol, olefins and petrol with a capacity of 20,000 metric tons/year will be put into operation.

At present from the basic thermoplastics only polyvinyl chloride is produced in the complex Bereodi-Vagyai on a unit with a basic capacity of 6,000 metric tons/year. Another unit with a capacity of 24,000 metric tons of polyvinylchloride is under construction. Both capacities should give 30,000 tons polyvinyl chloride per year in 1970 and the production of vinylchloride should double. The main attention will be paid to the production of polyvinyl chloride plastisols for the production of plastic leather.

The unit for the production of high pressure polyethylene is now under construction and is to produce 7,000 metric tons of polyethylene in 1968. This unit should reach its full production capacity of 24,000 metric tons of polyethylene per year in 1970. The capacity for the year 1975 is not yet fixed.

There exist two alternatives: either to increase solely the production of high pressure polyethylene to 37,000 metric tons or to increase the production both of the high pressure and low pressure polyethylene to 48,000 metric tons.

Construction of a polypropylene unit is provided for connection with the possibility both as a substitute for a certain quantity of low pressure polyethylene and as the raw material for the production of polypropylene fibers.

The production of polystyrene is not planned before the year 1975. A unit with a capacity of 10-20,000 metric tons/year should be built after 1975. It may use the technology of suspension polymerization entirely. Impact polystyrene and polystyrene forms should be also produced. The production of co-polymers is not provided for.

Polymethylmethacrylate and polyamides are produced in relatively small volumes.

6.5 Polish People's Republic.

Poland possessing considerable sources of many raw materials with the exception of crude oil trebled the chemical industry on the average every five years and today the chemical industry represents about 10 per cent of the total industrial production of Poland. In the growth rate of the chemical industry after the Second World War Poland ranks third after the U.S.S.R. and Japan and is among the first ten countries of the world in the total volume of chemical industry production.

In the present five year's period a slower growth rate of the chemical industry is planned in comparison with the past, nevertheless the value of the production of the Polish chemical industry reaches the index 2.5 in 1970 in comparison with the year 1965. This limitation corresponds to the present financial possibilities of the Polish national economy and to the capacities of their projection and construction organizations. Nevertheless the growth rate enables increasing the share of chemistry to 12.5 per cent in the total Polish industrial production in 1970.

Three trends may be noted in the programme of the Polish chemical industry development for the next years:

- 1) the increase in the productivity of agriculture, above all of vegetable production. The decisive factor for achieving this aim is the increase in production of chemical fertilizers and other chemicals for agriculture;
- 2) the production of synthetic fibres which is to form the raw material basis of the developed textile industry;
- 3) the production of plastics and synthetic resins. At present the development of this branch means only the first steps of supplying the Polish economy with modern raw materials. A threefold increase in the total production of plastics and synthetic resins is planned by 1970. The production of some thermoplastics of wide use, as polyvinyl chloride, will increase even four times.

Crude oil should ensure this increase in plastics and synthetic resins production. It is assumed that about 230,000 metric tons of basic petrochemicals (phenol, butadiene, ethylene etc.) will be produced in Polish petrochemical plants in 1970.

At present Poland ranks thirteenth in the world with 175,000 metric tons/year of plastics and synthetic resins. Nevertheless the production of 3.7 kg. per head is still far below the average of highly industrialized countries.

It is interesting that the present assortment includes almost all kinds of plastics and synthetic resins, which are produced in the world in larger quantities. The aim of this effort is to be independent of the import of products of wide use. Concerning plastics that can be produced only with a loss there is an effort to produce and utilize only such assortment which is economically profitable. Also only such plastics and synthetic resins are imported which can be used in small quantities to improve the quality of more expensive equipment and apparatuses.

The present situation in the main thermoplastics can be characterized in the following way:

Till the year 1966 only emulsion type polyvinyl chloride was produced. At present the suspension type is also produced and it is expected that 75

per cent of production of polyvinyl chloride will be produced by suspension polymerization in 1970. This polymer is above all used for plasticized products cables, flooring, plastic leather, but can be used also for rigid polyvinyl chloride products tubes, pipes, injection moulded products. The production of high pressure polyethylene started in 1966. This polymer is used above all for packaging and cable coatings. A semi-pilot plant for low pressure polyethylene was established according to Polish technology.

The production of polystyrene amounts to 7 per cent of the total production of plastics. About 19 types of polystyrene are produced for common use. The share of foam polystyrene is relatively large as insulating material for ship building, transport, and the building industry. The production of copolymers is not envisaged for the next period.

The production of polyvinyl acetate, largely for production of adhesives, should start in 1970.

Polymethylmethacrylate will be produced mostly in sheets and plates, only a small quantity will be processed by injection moulding.

A pre-pilot plant of polycarbonates for injection moulding and electro-insulating films is envisaged in the near future.

The production of polypropylene, fluoroplastic and polyacetals is not planned until 1970.

After the year 1970 a further significant development of plastics and synthetic resins is planned in which large petrochemical complexes which are now being constructed will participate. The units for the production of high pressure polyethylene and polypropylene should be established in the chemical complex at Plock. In the complex Wdai-rzyn Blachowni besides the high pressure polyethylene unit (Blachowni) a unit for the production of polystyrene and copolymers of styrene should be put into operation. In Oswiecim where there is an extensive reconstruction and modernization planned after 1970 polyvinyl chloride, polystyrene and polyvinyl acetate will be produced. The development of this complex is connected with the passing on to the petrochemical basis. The second producer of polyvinyl chloride will be the Tarnow complex, which works on the basis of natural gas. In the next stage the production of polymethylmethacrylate should be envisaged. Besides that, some plastics and synthetic resins should be produced in the chemical complex at Pulawy.

Forty one per cent of the total production of plastics and synthetic resins including raw materials for synthetic fibres produced in the above-mentioned complexes in 1965.

After the year 1970 these complexes are to produce on the whole about 290,000 metric tons of plastic and synthetic resins, that corresponds to 65 per cent of total output, from which 145,000 metric tons belongs to polyvinyl chloride, 50,000 metric tons to polyethylene and 25,000 metric tons to polystyrene.

6.7 The Socialist Republic of Roumania.

Roumania possesses enormous sources of raw materials for chemical industry and the government supports considerably the development of this branch. The chemical industry produces now days in a fortnight such a volume of production which equals the total production of this branch in 1938. In the year 1957 the volume of the chemical production was 4 times greater than that in the year 1950 and the annual average growth rate was about 23 per cent. This annual average growth rate of the chemical production in Roumania exceeds, according to the world statistical data, not only the annual average growth rate of the highly industrialized countries, but also of all the countries in the world with a tradition of chemical production.

The principal conditions of such a great extension of the chemical industry of Roumania are its large natural resources, above all large oil fields and natural gas resources.

On this raw material basis a large petrochemical industry was established. At present several large refineries of crude oil are in operation in Roumania. At Braza a catalytic reforming complex was built up with an output of 1 million metric tons per year of petrol. In the refinery in Georgiu-Daj a similar unit was put into operation with an output of 50,000 metric tons per year of petrol from which many aromatic hydrocarbons and light fractions for chemical production are obtained. Large plants and complexes were built at Borzesti, Braza, Ploesti, Gallova, Turgu-Mare and Tama Negura to utilize crude oil and natural gas products.

In Roumania of today petrochemical industry ranks first in the industrial production. In the year 1965 about 80 per cent of the total volume of

chemical production went to petrochemical production. In the period 1965-1970 about 55 per cent of the planned investment for the chemical industry is assigned to the building up of new petrochemical plants which may increase the production of petrochemicals 4 times in the year 1970 in comparison with the year 1965.

The new industrial complexes will start with a production capacity of 300,000 metric tons of urea per year, a unit with a capacity of 150,000 metric tons/year of organic solvents, equipment for the production of high pressure polyethylene with a production capacity of 48,000 metric tons/year, two units for production of polyvinyl chloride with a capacity of 36,000 metric tons/year etc.

Such a fast development of the Roumanian chemical industry is due to the fact that Roumanian chemical products penetrated the world market. The country imported most of its chemical products 25 years ago but became a known exporter of chemical products in a short time.

At present Roumania exports its chemical products into 70 countries of the world. Tyres are at the head of the Roumanian chemicals exports. Roumania exports tyres to the U.S.S.R., Czechoslovakia, Ghana, the U.A.R., Great Britain and Bulgaria. The greatest importers of Roumanian synthetic rubbers are the U.S.S.R., Czechoslovakia, the U.A.R., Turkey and Sweden.

The Roumanian production of plastics started at the beginning of 60's, but owing to the wide petrochemical basis it has been developing quickly. The plastics industry is the fourth most quickly growing branch of chemical production in Roumania after synthetic resins, fibres and fertilisers. New plants equipped with modern machinery mostly built and licensed by foreign firms increased the production of plastics and synthetic resins so that this production reached nearly 95,000 metric tons in the year 1966 compared with 75,000 metric tons in the year 1965 and 100,000 metric tons in the year 1967 respectively.

Polyvinyl chloride was the first plastics material produced in Roumania. The plants at Tirneveni and Turda are producing 6,500 metric tons of polyvinyl chloride. A new plant at Borzesti has a capacity of 36,000 metric tons. In the plant Rimnicu Vilcea there was constructed a new unit of vinyl chloride and polyvinyl chloride with a capacity of 40,000 metric tons of polymer. Klöckner-Humboldt-Deutz, Köln, Federal Republic of Germany, delivered the equipment. Vinyl chloride will be produced by oxychlorination of ethylene. Thus the total

capacity of polyvinyl chloride production will increase to 70,000 metric tons/year. A plant with an annual production capacity of 24,000 metric tons of high pressure polyethylene was put into operation in the petrochemical complex at Braza. Polystyrene and its copolymers in the quantity of 6,500 metric tons is produced in the synthetic resins plant in the town Georghiu-Dej. Polystyrene is also produced in the petrochemical complex at Floresti. In the plant at Gratiava a unit for the production of polyvinyl acetate with annual capacity of 20,000 metric tons was established. A unit for the production of adhesives, paints and varnishes from synthetic resins is placed in the chemical complex Victoriei and at Rynova.

The extension of these plants will increase the production of plastics and synthetic resins in Roumania from 77,000 metric tons in the year 1965 to 130-200 thousand metric tons in the year 1970.

6.9 The Union of the Soviet Socialist Republics.

The development of the chemical industry in the U.S.S.R. in the last 50 years has no analogy in any other country of the world, or in any of branch industry. It is characterized both by the total growth of volume, and also by structural changes, which have occurred in recent years.

The development of the chemical industry in the last period in comparison with the total growth of industry is illustrated in Table 9. The data represent the growth in per cent in comparison with the previous period.

Table 9: The development of the chemical industry in the U.S.S.R. in comparison with the total industry (in per cent in comparison with the previous period).

	1963	1964	1965	1966	1967 (1 half-year)
Chemical Industry	16.0	15.0	14.0	13.0	13.0
All Industry	3.1	7.1	8.6	3.6	10.6

In the years 1959-1965 about 9 billion Roubles were used for the construction of new production facilities and for the modernization of the

old ones and an amount of 14 billion Roubles for these purposes is planned for the period 1965-1970.

The growth and the share of the chemical production in total industrial production is evident not only as to the investment, but also as to the increase of the number of workers in the chemical industry, as is to be seen in Table 10.

Table 10: The number of workers in all industry of the U.S.S.R. and in the branches of the chemical industry (in 1,000 workers).

	1960	1964	1965
All Industry	16,574	21,435	22,206
Chemical Industry	584	870	935
Share of the Chemical Industry (per cent).	3.1	4.0	4.3

In recent years structural changes appeared in the development of the most progressive branches of chemistry. It took place especially after the year 1963, above all in the field of plastics and synthetic resins, synthetic rubbers, fertilizers and synthetic fibres.

Development of the plastic and synthetic resins industry is based on the petrochemistry.

New plants are built up in complete geographical zones, as for example the chemical complexes in the length of about 1,000 km. along the Volga from Kazan to Volgograd. The production of these complexes forms a link with existing plants and will be mainly confined to plastics and synthetic resins, synthetic fibres and synthetic rubbers. Another zone of petrochemical complexes with a similar programme is to be built up in Siberia.

Also in the future the centre of development for plastics and synthetic resins will be the thermoplastics, among them above all high pressure and low pressure polyethylene, polyvinyl chloride and polyvinyl acetate. The value of investment in the development of these products will reach 5.3 billion Roubles up to 1970. The raw material basis will shift to crude oil and natural gas and rise to 75 per cent in 1970, while 10 years ago still 60 per cent of new production was based on coal.

The total production of plastics and synthetic resins is to increase to 19-21 million metric tons by the year 1970. It would be about 15 kg. of plastics and synthetic resins products per head.

The development is assured not only by the extensive domestic research, but also by the broad minded licence policy, which counts on the import of complete petrochemical complexes with a wide pattern of products and for special equipment, for instance for fractionation of natural gas, and for the production of vinyl chloride, polyvinyl alcohols, acetylene and acrylonitrile, caprolactam and ethylene glycol.

Also an extensive import of plastic and synthetic resins such, as polyvinyl chloride, polyolefins, polycarbonates, is expected.

The production of plastic and synthetic resins in the U.S.S.R. in 1967 has been estimated at 271,000 metric tons. This is an increase of 25 per cent over the 1965 figure.

More than two thirds of this production go to synthetic resins and thermoplastics and one third to the thermoplastics for spool spinning. In all statistics these figures are published as one item.

In the U.S.S.R. the following plastic and synthetic resins are produced: aminoplastics and phenolic resins, low pressure and high pressure polyethylene, polypropylene, epoxide resins, polytetrafluoroethylene, polycarbonates and polyvinyl chloride. Several types of polystyrene are produced: bulk, impact, emulsion and suspension, copolymers with acrylonitrile or methacrylate, terpolymers and self-extinguishing type.

It is probable that this specification is not complete. It is possible to judge from many technological reports that there exist various new ways of processing particular plastics and synthetic resins, and that the intensity of development of processing methods for plastics and synthetic resins is high.

By the year 1970 the share of both types of polyethylene and polypropylene is to increase to 25 per cent. The present capacity of polyethylene is 200,000 metric tons, the share of low pressure polyethylene capacity being 60,000 metric tons. The present production capacity of polypropylene is 10,000 metric tons.

The main fields of application of plastics and synthetic resins should be machinery, building industries and agriculture.

6.9. Federative Socialist Republic of Yugoslavia.

The rapid development of the Yugoslavian economy has evoked a considerable interest in the world. Especially in its chemical industry characterized by rapid development and construction of new plants which are established mostly according to foreign projects and with basic foreign equipment.

The industrial production was 4.5 times greater than the industrial production of the last pre-war year. After some years of very rapid economic development the activity of the Yugoslavian industry weakened in the period 1960-1961. The annual average growth rate 12.3 per cent was reduced to 5.3 per cent or to 5.1 per cent respectively in those years. A favourable recovery took place in the year 1963 and the annual average growth rate increased to 14 per cent.

The utilization of foreign experiences was the essential factor which contributed to the industrialization of the country and also to the rapid building-up of its chemical industry. Before the war the chemical industry did not play a great part in the country in spite of a very good and wide raw material basis, especially for inorganic chemistry. The industry did not work to full capacities. The capacities were not utilized and the productivity of labour was very low. After the war the chemical industry developed more rapidly than other sectors of production. Its average annual growth rate in this period was 19 per cent while the annual average growth rate of the total industrial production in the same period was 12.1 per cent.

The development of plastic industry was also relatively slow. Up to the year 1956 polyvinyl chloride was the only plastic material industrially produced. The growth of its production in the subsequent years was dependent on the construction of new plants. In the year 1966 its production was roughly one quarter of the total production of plastics and synthetic resins.

The total production of other plastics and synthetic resins is in the following table:

Table 11: The total production of plastics and synthetic resins (except polyvinyl chloride) in Yugoslavia.

Year	Metric Tons
1956	766
1960	2,374
1961	5,659
1962	14,773
1963	17,933
1964	26,113
1965	47,066
1966	47,000

The total production of plastics and synthetic resins in 1966 was 62,000 metric tons. This figure can be broken down into:

Table 12: The structure of plastics and synthetic resins production in Yugoslavia.

Material	Metric Tons
Polyethylene	18,300
Polyvinyl chloride	15,000
Polystyrene	6,800
Aminoplastics	4,800
Cellulosics	4,600
Phenolics	2,900
Polyesters	2,100
Polyvinyl acetate	2,000
Miscellaneous	5,500

The consumption of phenolics and melamine plastics is larger than the production so that it is necessary to import them from abroad. A

reverse is supposed to come towards the year 1972 when the domestic production is likely to increase to such a degree that it will be possible to export a part of it. Up to now Yugoslavia had to import all raw materials for the production of synthetic resins. The first unit for formaldehyde was established in the plant Chronos in Zagreb. The necessary methanol for the production of phenol-formaldehyde resins was imported from the COMECON countries.

At present the main producers of thermosets are the plants in Gorazde, Lendava and Zagreb. The plywood, wood fibre and decorative board plants are a good market for phenol-formaldehyde resins. In some plants (Krivača, Spacva and Utro) the production of building components of plastics will be introduced as soon as possible. These parts may be profitably exported to Africa and Asia.

The development of the production of new thermoplastics is dependent on the establishment of the chemical complex OKI (Organsko Kemiska Industrija) in the outskirts of Zagreb. At the end of the year 1967 the following production capacities were available: 50,000 metric tons of ethylene by the pyrolysis of petrol (Foster Wheeler), 10,000 metric tons of high pressure polyethylene (ICI) and 10,000 metric tons of styrene prepared by dehydrogenation of ethylbenzene made from ethylene and benzene.

7. Exports and imports of plastics and synthetic resins in the COMECON countries and Yugoslavia.

In this respect only very few data have been published and those published indicate merely exports or imports of plastics and synthetic resins as a whole or, if specified, they are divided to specific groups without territorial division. Very often only values are published.

In general it can be said that the imports and exports of plastics and synthetic resins are altogether not very significant. At present almost all COMECON countries have a greater plastics and synthetic resins consumption than production. The production of the individual plastics and synthetic resins is mostly limited to some basic types. It is necessary to import the required special types and most of the COMECON members import them from western countries.

The plastics and synthetic resins exports from the COMECON countries to western markets are relatively limited and irregular. In no case it can be said that the COMECON countries gained some geographical areas.

Some quantitative data which are accessible are arranged into tables. In spite of their not being able to give an objective picture in the studied geographical area they can serve as support for the above-mentioned ideas.

The U.S.S.R. exports and imports plastics and synthetic resins to the Eastern Europe countries, above all to the COMECON countries. In the Table 13 there are some data about the imports and exports of some plastics and synthetic resins.

Table 13: The U.S.S.R. exports and imports of some plastics and synthetic resins.

Export	Unit	1965	1966
Plastics and raw materials	1,000 Mb	12,178	16,602
Synthetic resins	1,000 t	5.2	6.7

Table 13: The U.S.S.R. exports and imports of some plastics and synthetic (cont'd.) resins.

Import	Unit	1965	1966
Plastics and raw materials	1,000 lb	47,136	55,149
Chlorinated polyvinyl chloride	1,000 t	4.0	3.9
Polyvinyl chloride	1,000 t	28.6	23.3
Polyethylene	1,000 t	1.6	8.1
Polystyrene	1,000 t	-	25.0

A survey of the Polish foreign trade with some plastics is given in Table 14.

Table 14: Poland's foreign trade of plastics in 1966 (in metric tons).

	Import	Export
Polyvinyl chloride	10,500	4,000
Polyethylene	1,400	-
Polypropylene	30	-
Polystyrene	600	1,125
Caprolactam	-	3,000

In GDR the plastics and synthetic resins foreign trade concentrates on PVC which is its profitable export commodity. In the year 1965 30,000 metric tons of PVC powder were exported and in 1966 22,000 metric tons. In the year 1964 2,100 metric tons and in 1966 1,000 metric tons of polystyrene were exported. No data were published about the import of plastics and synthetic resins.

A survey of the thermoplastics import to Hungary is given in Table 15.

Table 15: The imports of the main thermoplastics to Hungary in the years 1965-1967 (in 1,000 metric tons).

	1965	1966	1967
Polyvinyl chloride	7.0	11.6	11.7
Polyethylene	4.5	5.4	8.5
Polystyrene	2.1	3.7	5.3
Polypropylene	0.3	0.8	-

The volume of polystyrene imports equals to the volume of consumption, because Hungary does not produce polystyrene. The pattern of the polystyrene imports in 1966 is given in Table 16.

Table 16: The pattern of polystyrene imports to Hungary in 1966 (in metric tons).

Polystyrene	Metric Tons
Standard	2,410
Impact	1,167
Foamed	144
Total	3,721

The polystyrene exports from Roumania in 1967 were 1,500 metric tons.

Table 17: The total production of plastic and synthetic resins in COMECON countries and Yugoslavia (in thousand metric tons)

	1955	1960	1961	1962	1963	1964	1965	1966	1967	1968	1970
Bulgaria	0.9	7.3	8.7	11.0	19.0	24.0	33.2	39.0	51.0*	70.0*	100.0
Czechoslovakia	32.0	63.2	73.7	97.1	95.1	100.0	124.0	155.0	167.0	170.0*	245.0
German Democratic Republic	72.1	115.2	133.4	160.0	15.6	203.7	213.0	246.0	273.0	311.0	407.0
Hungary	-	11.4	12.7	14.1	19.0	24.8	26.5	32.0	36.0*	40.0	100.0
Poland	11.7	55.4	65.6	83.0	99.1	100.0	118.0	132.0	167.0	200.0	341.0
Romania	1.1	12.4	17.3	23.8	30.7	47.7	75.5	94.7	100.0	131.0*	240.0
U.S.S.R.	151.4	293.4	358.0	421.7	507.2	641.0	767.8	882.4	971.0	1,312.0	2,100.0
Yugoslavia	5.0	9.6	13.6	22.9	26.4	34.4	55.6	62.0	75.0	80.0	140.0

* Estimated

Table 18: The production of polyvinylchloride in the COMECON countries and Yugoslavia (in thousand metric tons).

	1955	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Bulgaria	-	-	-	-	-	4.0	10.0	12.5	20.0*	30.0*	30.0*	40.0*
Czechoslovakia	3.0	10.9	19.0	20.3	21.0	23.4	26.0	28.2	32.5	35.0*	35.0*	45.0
German Democratic Republic	42.0	50.6	70.4	87.4	90.6	102.8	104.0	106.3	117.0	125.0	125.0	175.0
Hungary	-	0.2	0.3	0.6	2.9	5.8	6.5	6.9	7.3	9.0	9.0	30.0
Poland	-	13.4	14.4	15.6	16.4	25.6	26.4	26.9	33.4	45.0*	45.0*	106.0
Romania	0.1	4.0	5.5	6.4	6.4	16.0	31.2	37.9	40.0	45.0*	45.0*	70.0
U.S.S.R.	13.0	24.7	37.7	38.5	47.7	66.6	80.0	90.3	110.0*	120.0*	120.0*	150.0*
Yugoslavia	3.7	7.4	8.1	8.9	8.4	8.3	8.5	15.0	18.0	19.0*	19.0*	40.0*

* Estimated

Table 19: The production of polyethylene in COMECON countries and Yugoslavia (in thousand metric tons).

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1970
Bulgaria	-	-	-	-	-	-	-	-	-	-	-	0.9	3.0*	9.0*	30.0
Czechoslovakia	-	-	-	-	-	-	-	-	-	-	-	1.0	17.2	20.0*	32.0
German Democratic Republic	0.1	0.6	0.8	1.0	3.0	4.1	5.0	20.1	35.0	42.0*	50.0.				
Hungary	-	-	-	-	-	-	-	-	-	-	-	-	-	7.0	24.0
Poland	-	-	-	-	-	-	-	-	-	-	-	0.9	6.0	12.0*	44.0
Romania	-	-	-	-	-	-	-	-	-	-	7.0	17.0	25.0*	32.0*	84.0
U.S.S.R.	0.5	1.1	2.2	13.4	41.1	50.3	57.0	91.6	115.0*	130.0*	200.0				
Yugoslavia	-	-	-	-	-	-	-	8.0*	15.0	18.3	20.0*	23.0*	30.0*		

* Estimated

Table 20: The production of polystyrene in COMECON countries and Yugoslavia (in thousand metric tons).

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1970	1975
Bulgaria	-	-	-	-	-	-	-	-	-	-	-
Czechoslovakia	0.2	0.7	0.3	1.2	2.5	9.8	13.5	15.0	16.0*	2.5	40.0
German Democratic Republic	4.0	4.5	7.5	9.5	11.2	12.3	13.3	16.2	19.0*	24.0	53.0
Hungary	-	-	-	-	-	-	-	-	-	23.0	55.0
Poland	3.7	6.9	8.1	8.5	9.9	10.6	12.2	12.2	15.0*	-	10.0
Romania	-	-	-	-	3.7	4.3	4.4	4.4	5.0*	20.0	30.0
U.S.S.R.	7.5	11.0	14.9	20.5	27.8	28.9	35.7	40.0	45.0*	7.0	15.0
Yugoslavia	-	-	-	-	4.5	5.0*	6.8	7.0*	7.0*	50.0	100.0
										7.0	15.0

* Estimated

Table 21: The production of aminoplastics in the COMECON countries and Yugoslavia (in thousand metric tons).

	1964	1965	1966
Bulgaria	13.7	15.4	17.1
Czechoslovakia	15.4	19.7	22.2
German Democratic Republic	2.3	3.8	4.4
Hungary	6.7	7.1	9.2
Poland	24.6	27.3	28.7
Romania	19.0	20.5	22.2
U.S.S.R.	136.6	165.3	216.3
Yugoslavia	-	-	-

Table 22: The production of acetylene in the COMECON* countries and Yugoslavia (in thousand metric tons).

	1964	1965	1966
Bulgaria	6.9	14.4	18.3
Czechoslovakia	45.2	46.4	47.7
German Democratic Republic	414.4	426.2	445.9
Hungary	3.9	14.4	18.3
Poland	149.0	162.3	170.4
Romania	31.3	33.0	41.4
U.S.S.R.	192.1	196.5	233.0
Yugoslavia	-	-	-

* Estimated from the carbide production

Table 23: The production of propylene in the COMECON countries and Yugoslavia (in thousand metric tons).

	1965	1966	1967	1968	1970	1975	1980
Bulgaria	-	-	-	35.0	50.0	75.0	-
Czechoslovakia	25.0	35.0	50.0	60.0	60.0	111.0	186.0
German Democratic Republic	2.5	12.0*	24.0*	40.0	54.0	115.0	300.0*
Hungary	-	-	-	-	12.0	36.0*	75.0*
Poland	-	-	12.0	26.0	60.0	170.0	370.0
Romania	5.5	8.0*	10.0*	20.0	74.0	162.0	270.0*
U.S.S.R.	20.4	25.0*	35.0*	40.0*	70.0	100.0	300.0*
Yugoslavia	-	-	-	15.0	15.0	50.0*	90.0*

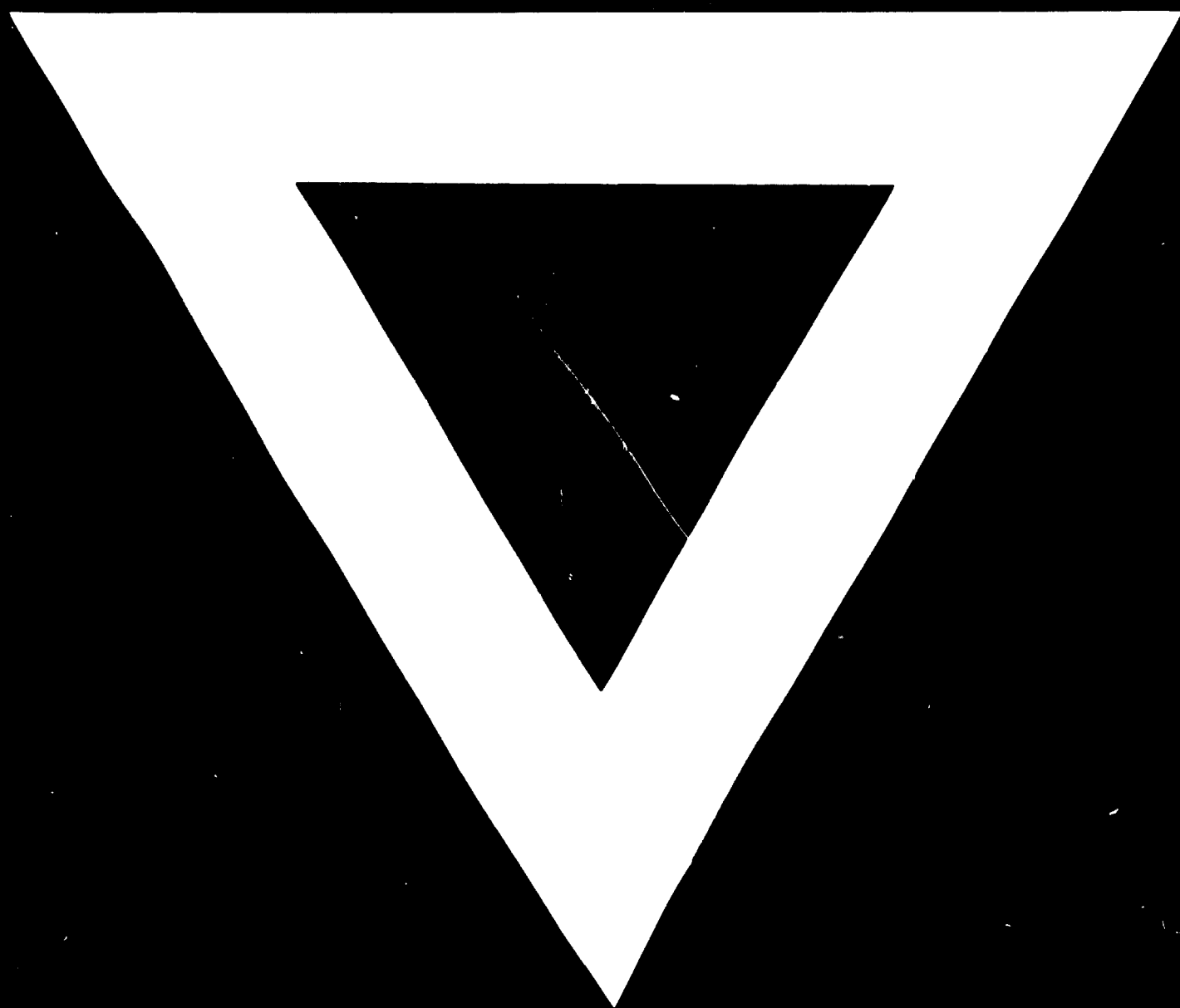
* Estimated

Table 24: The production of ethylene in the COMECON countries and Yugoslavia (in thousand metric tons).

	1964	1965	1966	1967	1968	1970
Bulgaria	-	-	-	-	170.0	170.0.
Czechoslovakia	-	60.0	60.0	110.0	110.0	110.0
German Democratic Republic	44.3	45.3	65.9	80.0*	100.0	200.0
Hungary	-	-	-	-	25.0	25.0
Poland	-	10.0	10.0	30.0*	65.0	170.0
Romania	-	12.0	24.9	35.0	35.0	100.0
U.S.S.R.	40.0	60.0*	80.0*	90.0*	120.0	175.0
Yugoslavia	-	-	-	-	50.0	50.0

* Estimated





4 . 4 . 72