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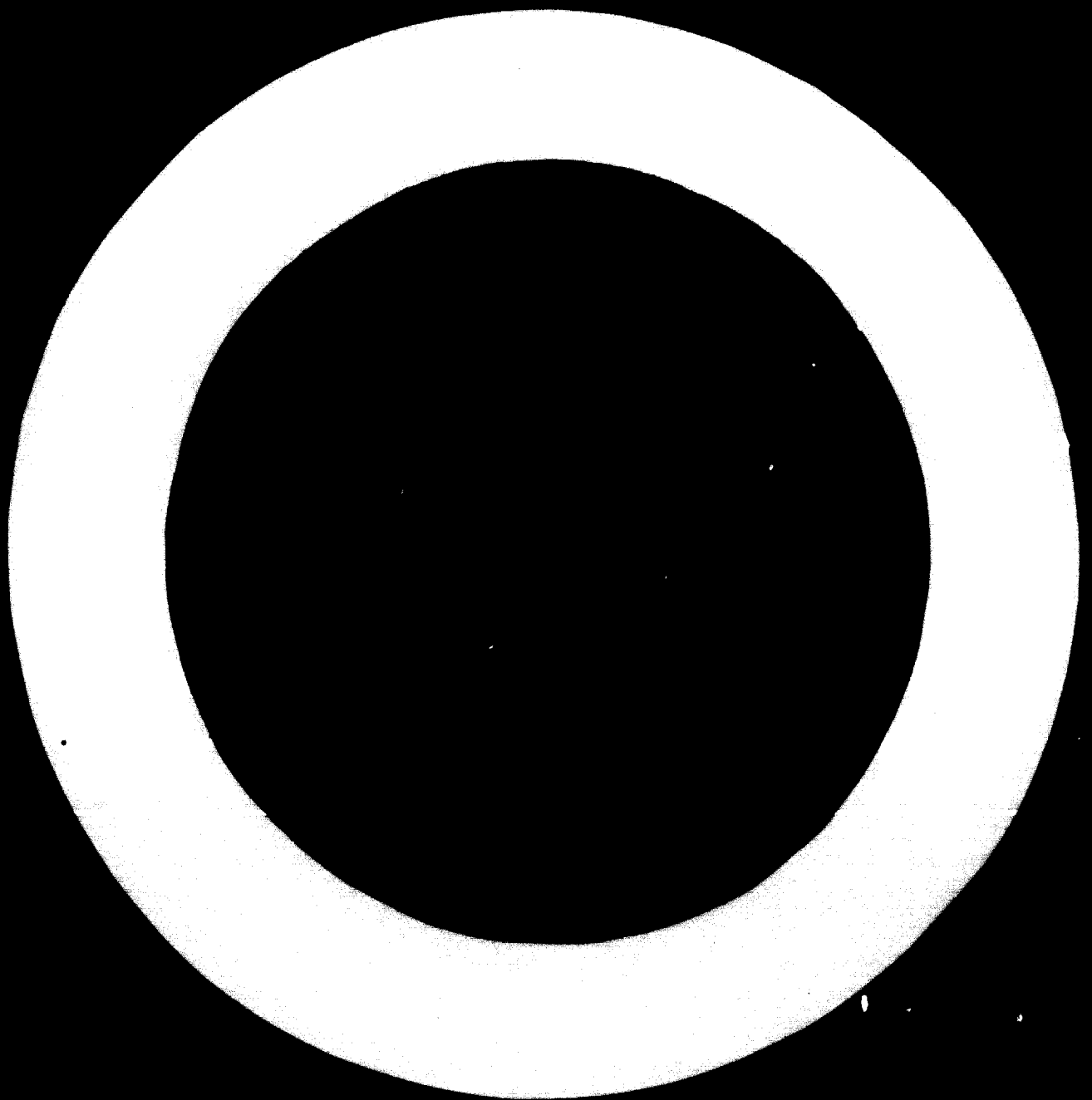
THE CONSTRUCTION PROGRAMME FOR A SYNTHETIC
RUBBER PLANT IN YUGOSLAVIA ^{1/}

by

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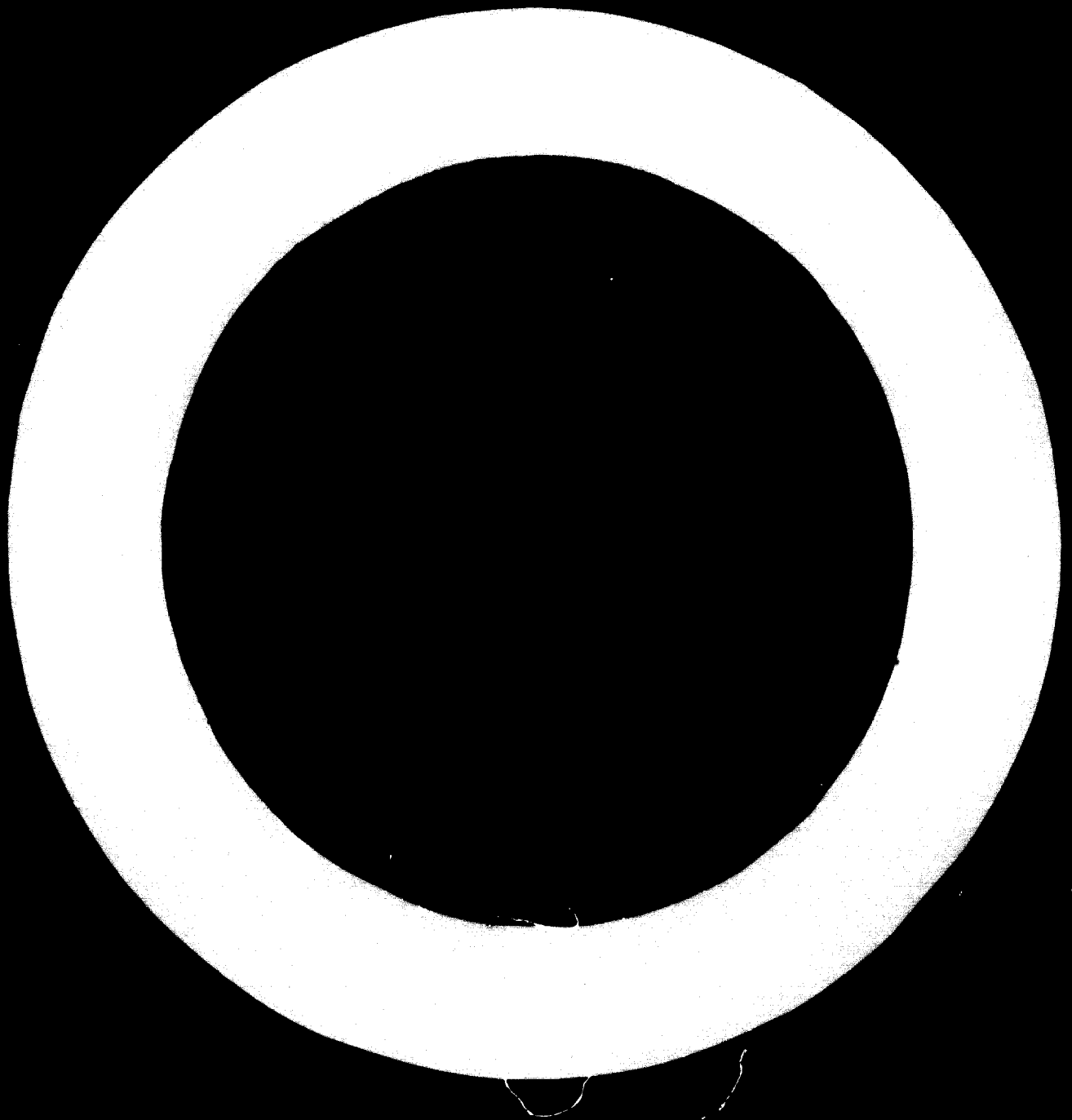
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I. INTRODUCTION

The possibilities of synthetic rubber production in Yugoslavia have been discussed during last ten years, when several studies have been made, and two projects have been worked out. However, all the calculations indicated the negative economic effects.

The first reason for negative economic effects in previous studies lay in a relatively small and undeveloped market of rubber products, and even in consumption of synthetic rubber, i.e. very important reason is deficiency of convenient raw materials, because of the poor, one-sidedly developed petrochemical production in Yugoslavia.

In the meantime the situation began to change and during 1975/6 the essential prerequisites should be acquired, which would enable the beginning of production of synthetic rubber in Yugoslavia.

The rapid development of automobile industry, and to some extent also of the other industries consuming rubber products, will enable the consumption of elastomer of about 90,000 t/a 1975, and 130,000 t/a in 1985, respectively. Such a consumption of elastomer indicates the necessity for production of general purpose synthetic rubber, although even then, the initial capacity will be relatively small in respect of the capacities in industrially developed countries. However, having in view that even at the beginning, 4/5 of production will be sold in our country, the positive economic effects are obtained, which would not be the case if a major part had to be exported at the export prices, competing with the large world producers, with drop in prices in dependence on customs barriers and transportation charges.

By construction of olefine complex in Pančevo, with capacity of 200,000 of ethylene, which should be in full operation in 1976-7, C_4 fraction will be a by-product, which will contain more than 25,000 t/a of butadiene.

The availability of such raw material will enable construction of a plant with capacity of 40,000 t/year of SBR, partially oil extendend.

The detailed explanation of the market's growth rate and of the reasons for adoption of certain type of elastomer, are given in the following report.

II. SURVEY OF DEVELOPMENT OF RUBBER MANUFACTURING INDUSTRY IN YUGOSLAVIA

The rubber manufacturing industry began to develop rapidly in last fifteen years, as the result of the development of automobile industry. Previously, it almost did not exist. Production of footwear and different technical goods was only a handicraft; as pneumatic tyres are concerned, there was only an insignificant production of tyres for bicycles and lorries. During that period a number of plants was built for the production of tyres. Nowadays, their production takes part in the whole production of rubber industry with 55%. It is lower than percentage of the corresponding share in developed countries, where it amounts to 70%, but it will continue to increase along with the development of domestic automobile industry.

In table I are listed several large rubber manufacturers together with the size of their production in tons.

TABLE I

RUBBER MANUFACTURERS IN YUGOSLAVIA

	Tyres	Technical rubber goods	Rubber footwear
"Borovo", Borovo	11,820	6,358	5,969
"Sava", Kranj	15,231	4,895	-
"Tigar", Pirot	9,966	2,329	2,912
"Rekod", Rakovica	3,386	5,432	-
"M. Zakić", Kruševac	1,868	228	-
"Ris", Zagreb	-	5,456	-
"Balkan", Suva Reka	-	1,600	-
"Vulkan", Niš	-	1,106	1,784
"Zlatar", Nova Varoš	-	665	808

In the period from 1970-71, in rubber manufacture industry and handicraft, the achieved level of production was as follows /table II/.

TABLE II

PRODUCTION OF RUBBER MANUFACTURING INDUSTRY

Name of the product	Y e a r	
	1970	1971
Tyres /t/	42,252	47,342
Technical rubber goods /t/	29,474	33,155
Rubber footwear /ooo pairs/	10,977	9,459

Rate of production growth of the groups enumerated above during the period from 1966 to 1970, with forecast for 1975, is shown in table III.

TABLE III

RATE OF PRODUCTION GROWTH

Production grouping	Average annual rate of growth	
	1970 - 1966	1975 : 1970
Tyres	15,5%	20,4%
Technical rubber goods	9,2%	11,5%
Rubber footwear	1,9%	4,6%
Total	8,9%	15,6%

An average rate of growth for pneumatic tyres at that period amounted to 15%, while for the period 1970-75 it will amount even to 20%. According to the Plan of Rubber Industry Development, the greatest investment is projected into this grouping, taking into consideration the new radial tyres production. Such rate of growth was predicted according to the expected development of domestic automobile industry and increased degree of motorization in Yugoslavia. The last one is still several times lower in Yugoslavia than in West European countries Table IV, and there are still great possibilities for further expansion of production or import of passenger cars to meet the domestic demand.

TABLE IV

THE COMPARASION OF PASSENGER CARS NUMBER

Country	No of inhabitants/car
USA	2.3
Canada	3.2
W.Gernany	4.4
G.Britain	4.8
France	3.9
Japan	11.8
Australia	3.2
Italy	5.3
Niederland	5.2
Yugoslavia	28.4

The situation presented is related to statistics from 1970 year. The rate of growth for passenger car number in Yugoslavia is shown in Table V.

TABLE V

RATE OF GROWTH FOR PASSENGER CAR NUMBER IN YUGOSLAVIA

Year	1971	1972	1975	1980
No of carr	873,000	999,540	1.800,000	3,600.000
No of inhabitants/car	23.5	20.5	14.2	6.0
Annual rate of grow th		14.5	26.7	20.0

On the basis of the development programme for domestic car industry and trend of growth of rolling stock in exploitation, the present and prospective needs for tyres were estimated as it is listed in table VI.

TABLE VI

PRESENT AND FUTURE CONSUMPTION OF TYRES IN YUGOSLAVIA

Year	Passenger cars		Trucks		Total	
	ooo pieces	t	ooo pieces	t	ooo pieces	t
1968.	1,220	8,949	792	34,452	2,012	43,401
1969.	1,604	11,255	943	41,142	2,547	52,897
1970.	2,088	15,259	1,061	45,594	3,149	60,853
1971.	2,569	18,806	1,187	50,753	3,756	69,559
1972	3,006	22,026	1,321	56,138	4,327	78,164
Rate of growth/%/		25.3%		13.2%		16.0%
1975.		43,170		81,180		124,350

Taking into consideration all these facts one can predict the characteristics and size of future rubber manufacturing industry production in Yugoslavia. As it is mainly supposed to be tyre production, there are two possibilities for its growth: one simultaneous with the increase in requirements, and the other one much slower, but supplemented from export. For next several years, the second alternative seems more feasible.

100 IMPORT OF RUBBER TYPES OF FINISHED PRODUCTS

Natural and synthetic rubber are both imported in Yugoslavia, as there is no synthetic rubber plant established. As it is shown in table VII, there is a noticeable tendency of increase in imported quantities of synthetic rubber with decrease in natural rubber quantities, respectively.

TABLE VII

IMPORTS OF ELASTOMERS IN YUGOSLAVIA

Type of rubber	Year		
	1970	1971	1972
Natural rubber	19,000	22,000	17,000
Synthetic rubber	31,000	29,000	36,000
Total	50,000	51,000	53,000
Synthetic rubber/%	62.31	56.86	67.92
Natural latex	2,146	2,523	2,656
Synth.latices	2,575	3,128	3,233
Total	4,721	5,641	5,889
Synth.latices/%	54.54	55.45	54.89

The natural /synthetic rubber ratio was 0.47 last year, whereas the ratio of corresponding latices was 0.82.

Until 1967 natural rubber was imported mostly from Indonesia, and later on from Malaysia. However, synthetic rubber was imported mostly from western countries /about 70%/, while in last years the primary place in import is held by USSR, East Germany, Poland and Czechoslovakia.

Except the imports of elastomers, Yugoslavia has to import manufactured rubber goods, tyres, mastics, technical goods and footwear. The imported tyres are usually of size which is not made in Yugoslavia. In addition to that, Yugoslavia exports some quantities of its tyre production. However, Yugoslavia is spending more and more foreign currency each year for purchasing of elastomers and rubber products. In the period between 1969-1971 the balance between values of imports and exports in rubber manufacturing industry was as follows: /Table VIII/

TABLE VIII

IMPORT AND EXPORT OF RUBBER

/in million \$/

	Y e a r		
	1969	1970	1971
Import	31.6	39.5	56.4
Export	4.0	5.7	10.0

Presently, Yugoslavia is "heavy" importer of rubber, because export value makes only 17% of imports value, and this situation will be even worse in future. This is one of the main reasons for the establishment of domestic synthetic rubber industry.

IV. FORECAST OF NATURAL AND SYNTHETIC RUBBER CONSUMPTION IN YUGOSLAVIA

The tendencies of rubber industry development that were already pointed out, are in accordance with the proposed Plan of Economic Development of Yugoslavia during 1971-1975 period, adopted in Federal Assembly in June, 1972.

This document envisages the intensive modernization of Economy, increase in work productivity, with a faster growth of export and substantial slow-down of imports.

The emphasis of development in chemical industry will be on the basic chemical industry, whereby the petrochemical industry will be developed most rapidly. Within this branch of industry synthetic rubber production of 50,000 t/a is also envisaged. In connection to that, the future consumption of rubber was estimated according to the planned increase in production capacities of rubber manufacturing industry for the period until 1985. The data are given in the table IX.

TABLE IX

FORECAST OF PRODUCTION

	/t/		
	Y e a r		
	1971	1975	1985
Tyres	57,140	124,000	180,000
Technical rubber goods	48,311	74,487	105,000
Rubber footwear	16,870	18,530	15,000
Total	122,321	217,017	300,000

Accordingly, the consumption of rubber in last three years with the forecast growth in 1975-85 period is given in the table X.

TABLE X

FORECAST OF RUBBER CONSUMPTION

Year and type of elastomer	P r o d u c t s			total	SBR
	Tyres ●	Technical	Footwear		
1970.					
Natural Rubber	15,913	5,229	1,591	22,733	
Synthetic Rubber	4,041	10,568	4,229	18,838	15,000
Total	19,954	15,797	5,820	41,571	
1971.					
Natural Rubber	18,400	6,744	1,974	27,118	
Synthetic Rubber	10,741	10,124	3,087	23,944	18,500
Total	29,141	16,860	5,061	51,062	
1975.					
Natural Rubber	35,944	9,200	568	45,812	
Synthetic Rubber	27,296	13,800	2,672	43,768	34,800
Total	63,240	23,000	3,240	89,580	
1985.					
Natural Rubber	50,080	13,020	540	63,640	
Synthetic Rubber	41,720	19,530	2,160	63,410	51,500
Total	91,800	32,550	2,700	127,050	

Table X represents the present and future consumption of SBR, too, as it takes 80% of total amount of synthetic rubber consumed.

The quantities of other, special purpose types of synthetic rubber, which will be used in the next twelve years are small, as they all account for 20% portion of the total synthetic rubber consumption in the country. According to the forecasts made by the experts, the share of SBR should be increased even more, due to steady tendency of replacing natural rubber by synthetic one.

V. SBR-REASONS FOR ADOPTION OF TYPE AND CAPACITY

Keeping in mind the situation of the world production and consumption of synthetic rubber and its increasing consumption in Yugoslavia, it becomes clear that Yugoslavia should begin to solve the problems of supply of synthetic rubber from own production, erecting the general purpose synthetic rubber plant. Last year, Yugoslavia paid for the import of elastomers nearly 21 million \$.

Today and in near future, production of SBR in Yugoslavia seems completely justified. It is the most widespread type of synthetic rubber in the world with well known and established technology. SBR is the cheapest synthetic rubber today, with relatively easily available raw materials. SBR capacities represent 2/3 of the total synthetic rubber world capacities today, and its production makes 60% of the total amount of synthetic rubber produced. SBR is supposed to cover 80% of our requirements of synthetic elastomers and in that way our import would be reduced to a great extent.

This investment programme envisages production of SBR which would be partly oil-extended, with capacity of 40,000 t/a. The capacity of the future plant is conditioned by two essential factors:

- requirements of the Yugoslav market
- availability of raw materials

As may be seen from table X, the expected SBR consumption in 1975 will be about 35,000 tons, whereas in the period until 1985 it would grow up to about 51,500 tons. Accordingly, even at the beginning of production, about 88% of produced rubber would be consumed in the country, whereby this percentage would be gradually increased.

Raw materials

As raw materials are concerned, butadiene, the basic one will be available in Yugoslavia. There is a big olefine complex being erected at Pančevo presently, and the available quantity of butadiene amounts to 25,000 t/a. It is possible to make about 40,000 t/a of SBR out of that quantity, and that will be sufficient to meet the demand in near future. SBR production should be oriented towards obtaining oil-extended rubber to the greater extent, because it yields economic advantages. The market analysis have also shown that oil-extended rubber is consumed in double quantity.

Styrene 8,000 t/a of styrene should be provided from import, most probably from Romania, in which case payment will be effected by exchange of petrochemical products.

Extender oils and some other chemicals, that are required for production of SBR, will be mostly imported.

Processes for SBR Production

SBR can be obtained by emulsion process, hot /50°C/, or cold /5°C/ solution polymerization process.

Hot process is generally abandoned now because cold process yields SBR of better quality.

There are certain differences in micro and macro structure of the polymer molecules obtained by different processes. These structure characteristics mainly contribute to the properties of the elastomer during its processing and service life.

So, cold emulsion type has better elastic and processing properties and has almost completely superseded the hot type. The majority of SBR in the world today is produced by cold polymerization process in emulsion. Solution type is rather new one, as its production started in 1965. It has some advantages when it is compared to emulsion type. However, at present, its quality does not meet completely the requirements of tyre producers and therefore, only small quantities of solution SBR are used for these products. The mostly quoted reasons are: high price and more difficult processing of the new type.

Solution polymerization plant seems to be easier to run, provided that during polymerization, water and oxygen are completely excluded. Some of the advantages of the solution process are:

- 98% conversion of monomers
- production of polybutadiene in the same plant
- easy cleaning of the plant
- simple waste water treatment

The total world capacity for SBR production amounts to 4,816,000 t/a in which solution type takes part with about 10%.

This amount is expected to increase to 6,000,000 t/a until 1974 and with the new capacities, the percent participation of solution type will be increased significantly. However the solution polymer is not widely used for the production of tyres, and it is not possible to predict its future position on the market.

Taking these facts into consideration it was rather difficult to decide, which one of two possible types of SBR would be produced.

Due to such situation and keeping in mind that rubber market in Yugoslavia is not very familiar with solution elastomers, this program is considering the production of emulsion SBR.

Nevertheless, it is expected that UNIDO can help in this matter, and if it is necessary, the techno-economic criteria of the plant will be revised for the solution type.

VII. TECHNO-ECONOMIC CRITERIA OF THE SYNTHETIC RUBBER PLANT

This plant will have a design capacity of 40,000 t/a. The future plant is foreseen to produce 12,000 t/a of dry rubber and 28,000 t/a of oil-extended one.

Excluding off sites, the plant is divided into four basic sections:

- storages for monomers and the solutions make-up building
- reactor area
- recovery area
- building for finishing facilities and storages for rubber.

The beginning of synthetic rubber production is foreseen for 1976.

The Construction Costs and Economic Indexes

The factory is going to be built "grass root" and the total construction costs are estimated to about 17 million \$.

Out of that sum, 7 million \$ will be in foreign currency and will cover the costs of equipment, engineering and other necessary costs.

The cost of equipment for the "battery limit" was estimated, according to the data from several farms, to 4,280,000 \$ including waste water treatment.

The total number of people who will run the factory, including administration is 124. Eleven of them are highly educated, 43 are technicians and others are highly qualified, skilled and unskilled workers.

The anticipated time of construction is three-years term, so that net sale is expected only in the fourth year.

The whole annual expenditure will amount to 9,980,000 \$, net sales are estimated to 14,148,000 \$. Therefore income and net income will be about 4,170,000 \$ and 2,730,000 \$ respectively. Depreciation amounts to 1,160,000 \$.

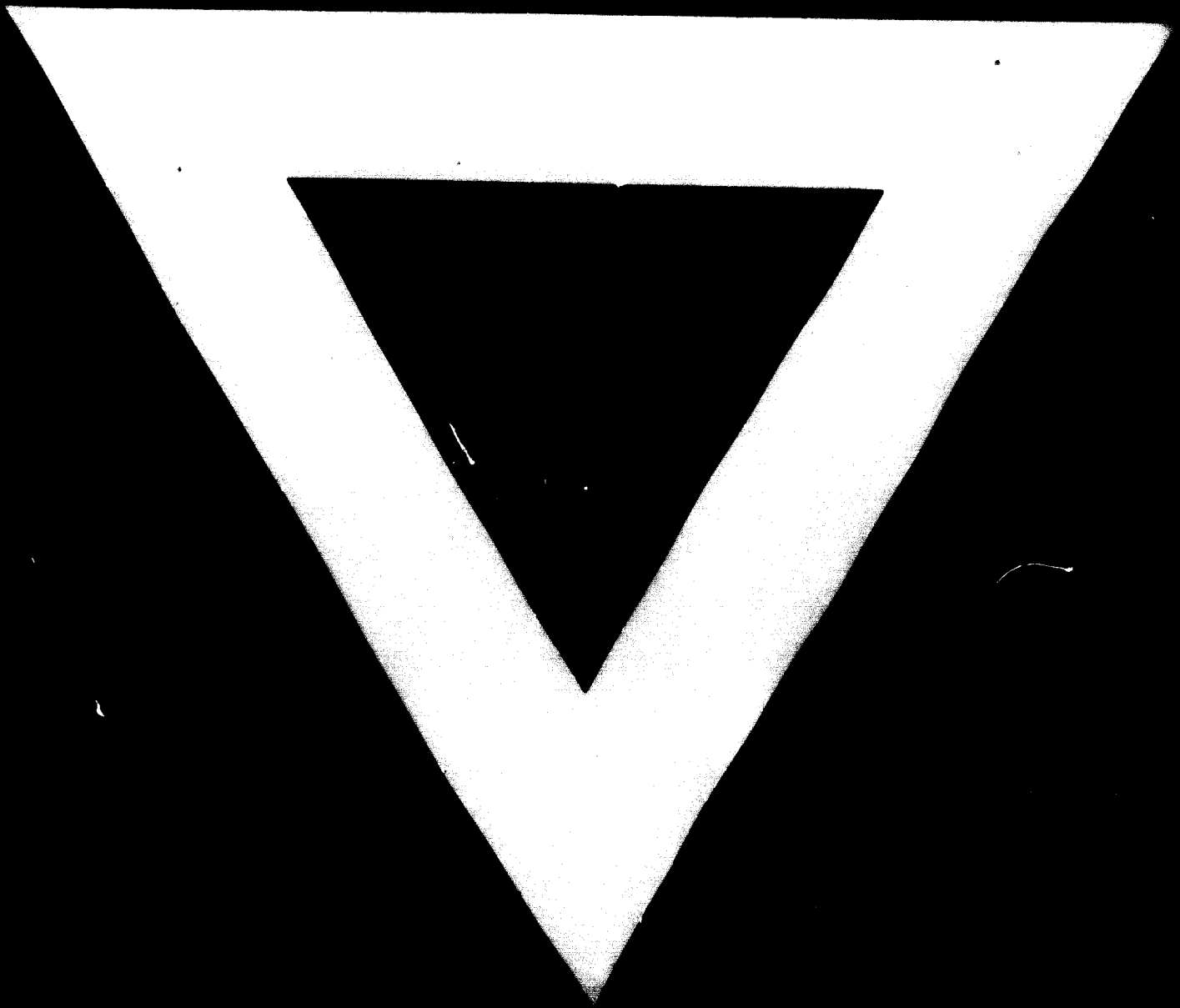
It is estimated that in the first year of operation, the plant will be used with 70% of its capacity, in the second year 90% , and full capacity will be achieved in the third year. The profitability obtained indicates net income ranging from 1,240,000 \$ to 2,700,000 \$ during ten years period of credit repayment. On the basis of such business operations, the net income of the plant will be equal to investment share soon after the fifth year of operation.

The prices of products used for net sales estimation are similar to the local prices in West European countries. Such a level of prices guarantees an average profitability of invested capital. It is obvious that size of the plant (40,000 t/a) is limited by the quantity of available butadiene. With such capacity, the plant is on the lower scale of optimum and must be protected by the measures of the economic system. Under such conditions, it cannot be expected that production costs will be lower, as compared to the production of SBR in Italy or W. Germany.

The level of selling prices, with which domestic rubber will enter the market, in Yugoslavia, where there are already large producers from East and West Europe, is very important one. The prices foreseen by the program: SBR - 420 \$/t and SBR 1700 - 330 \$/t cannot survive without special protection by the economic system at least to such an extent to which the foreign supplies are stimulated by their local export trade systems.

As it was already mentioned, the future synthetic plant has priority according to the present Plan of Economic Development of Yugoslavia, and its establishment will be supported by the Government. Some of the special protection measures, in connection with customs regulations and tariffs for the plant equipment, have already been proposed and adopted. It is expected that some other benefits will be accepted, too.





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