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An 18-page study on the synthetic rubber industry in the USSR

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THE CHEMICAL INDUSTRY of THE USSR under THE SEVEN-YEAR PLAN

The Caoutchouc Industry

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Introduction

Caoutchouc is one of the strategically important raw materials. In the USSR it is one of the very few, perhaps the only one of the strategically important raw materials which do not occur naturally or can be produced in the country itself. The modern synthetic chemical industry whose products derive from crude petroleum, natural gas, coal, and cellulose (wood) processed in the petro-chemical industry with a view to obtaining caoutchouc, plastics, and laquer components has proved itself capable, however, of supplying synthetic compounds which can easily competed with natural caoutchouc in regard to quality and price.

In the USSR the chemical industry on the whole was previously somewhat grudgingly catered for. It is true that the USSR was one of the first countries to produce synthetic caoutchouc. This production, however, was based, and still is, to some extent, on alcohol derived from foodstuffs (grain, potatoes). A synthetic-chemical industry in the modern sense was established only in very recent years. The current Seven-Year Plan has greatly accelerated the development of this branch of industry.

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The Chemical Industry of the USSR under The Seven Year Plan

The Caoutchouc Industry (1961)

According to the Seven-Year Plan the USSR intends, before the end of 1965, to increase its caoutchouc production by about 250 per cent in relation to 1958, that is from 230.200 tons to about 640.000 tons.

At the same time a demand is made for a major improvement of quality, and for the addition of new types of caoutchouc with special properties. Furthermore, the USSR's caoutchouc industry is to be made independent of import not only of natural caoutchouc, but also of special synthetic types of caoutchouc. The greatest consumer of caoutchouc in the USSR, [redacted] which take in 70-80 per cent of the caoutchouc production, have been faced with demands for increased wearability, road-worthiness, and durability generally. This necessitates not only an improvement of the quality of the caoutchouc but also [redacted] active filler components. 50X1-HUM

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1. The Reason for the Demand for the Forced Development Was:

1.1. The increasing transport requirements on land and in the air necessiate an equivalent increase in [redacted] production. 50X1-HUM

1.2. The increase in speed necessitates an improvement of [redacted] the quality of the caoutchouc. 50X1-HUM

1.3. Special strategic interest attaches to the "urgent" task set by the Seven-Year Plan of developing elastic materials, which can be used at temperatures between far below zero to 500 degrees centigrade. The Central Committee of the Communist Party declares in a statement of May 1958 that it is the development in air transport, in the production of intercontinental guided missiles and satellites which necessitates a major effort in this field.

No specified account of the military requirements in the caoutchouc industry has been available , but the following points may be stressed: At supersonic speeds the temperature in aircraft rises in consequence of kinetic heat (frictional heat) being produced. The considerably increased landing speeds make heavy demands [redacted] The lubricants that are used in the most recent types of engines for aircraft, missiles etc. attach, at high temperatures, machinery parts made of caoutchouc (gaskets, pumps etc) Many fuels (e.g. hydrogen dioxide, fuming nitric acid) require special corrosion-resistant materials. 50X1-HUM

2.1. Development Research in the USSR is extremely well organized and very thorough-going, and becomes particularly fruitful through a close cooperation between tha various sciences involved (physics, chemistry, mathematics) at research institutes and laboratories. The staff of researches is being continually increased.

Systematic research is being carried out with regard to the chemical processes which convert monomers into the high-molecular compounds (see section 7) which are the products of synthetic-chemical industry e.g. caoutchouc, plastics, lacquer raw materials. This research leads to new methods of synthesis for known and an increasing number of new materials, the properties and possible applications of which are being tested with the latest aids of science. New catalysts are also being found (see section 7) which may simplify, and cut the costs of, the chemical processes.

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With regard especially to materials resembling caoutchouc, the development of the following qualities is being aimed at: heat resistance, oil resistance, wearability, electric properties, weather resistance, ageing, ease of working, etc.

2.2. In the technological field the researches aim at putting the results arrived at by science to practical use. Various types of caoutchouc are being combined in order to utilize to the greater possible extent the properties of each type- Caoutchouc is also being combined with other synthetic materials. At the technological institute of the rubber industry at JAROSLAVL, a new material "resinoplast" has been produced and is said to possess such properties that [redacted] will be of "practically unlimited durability". At the same time, [redacted] production costs will be reduced by one-half!

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2.3. As to the industrial exploitation of the results promised by science and technology, the planning appears to be desultory and altogether deficient. This leads to considerable delays in putting new industries on a sound footing. Building and machinery deliveries are ill coordinated. It is said that the buildings erected for the manufacture of a certain article may stand in readiness for several years before the necessary machines are installed. In the meantime the buildings are used for other purposes, as for instance rocket engine and fuel tests. This appears to be the case with buildings at DNEPROPETROVSK [redacted] A certain building was described [redacted] in 1956, as being used for fuel tests and, in 1959, in "Kauchuk i rezina" as housing a [redacted] which displayed a high degree of automation [redacted]. Delays are also due to shortage of [redacted] all categories (experienced technicians, skilled and unskilled [redacted]). Large-scale production has initial difficulties traceable to raw materials varying in quality (purity) from those used in the laboratories. It is probable that certain special types of synthetic caoutchouc, to be used initially only in relatively small quantities, are produced and processed at the technological institutes of the rubber industry, e.g. at JAROSLAVL. This may apply to a.o. elastic materials for missiles, satellites etc.

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3. The Development of the Caoutchouc Industry in the USSR.

The acceleration of the caoutchouc industry must be based on synthetic types of caoutchouc, as natural caoutchouc cannot generally be produced inside the Soviet Bloc.

Thus the para-rubber tree, Hevea Brasiliensis, is excluded. From this tree nearly all natural rubber is obtained. It is grown in plantations (hence "plantation caoutchouc" or "plantation rubber") in tropical areas especially in the Far East (Malaya, Indonesia, Ceylon, Indo-China and elsewhere). The milk sap of this tree has a caoutchouc content of up to 35 per cent. Before the war ind in the first post-war years the USSR carried out experiments on a very large scale the aim of which was the production of caoutchouc from native plants. The experiments with the Kok-Sagyz and the Tau-Sagyz plants attracted a good deal of attention but were never made to answer, and have since been practically given up. Whether the USSR has made similar attempts with such caoutchouc-bearing plants as Taraxacum and Guayale is not known. The latter plant especially might prove remunerative. It is being cultivated in plantations in Turkey, among other countries, with economically satisfactory results. The Guayale plant grows well in chalky soil without watering.

Interest in the synthetic production of caoutchouc was aroused even before the communists came into power in Russia (S.V.Lebedev). It was not until 1931, however, that an experimentel plant supplied a product obtained from

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ethyl alcohol made from food plants (grain, potatoes). The method employed resulted in a buna caoutchouc (sodium butadien caoutchouc or sodium divinyl caoutchouc). The method differed considerably, however, from the one used by the Germans and the resulting product was of unsatisfactory quality. Nevertheless the method continued to be used, thus precluding qualitative improvements, and no such improvements were observed until 1948.

Since then production of an increasing number of synthetic caoutchoucs has been begun [redacted] At the same time endeavours are being made to relieve the foodstuff sector as supplies of raw materials by the employment of petro-chemical raw materials.

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The quantitative development of production is shown in Table I. See also Appendix 1.

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[redacted]

After the Japanese conquest in 1942 of the greater part of the platation areas of the Far East, a large-scale production of synthetic caoutchouc became imperative. Production rose from about 2000 tons in 1939 to about 800.000 tons in 1944, a fantastic industrial achievement. After the war the production fell again in spite of the enormously increased total consumption of caoutchouc [redacted]. This was due to the competition offered by natural caoutchouc which was still preferable for the chief applications. In recent years, however, synthetic caoutchouc has shown itself increasingly capable of competing as to quality and price. [redacted]

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This fact is emphasized because it confirms the belief that the USSR's object to become independent of natural caoutchouc can be achieved. It is only a question of production capacity.

To facilitate the evaluation of the figures shown in Table I some further facts may be added:

In 1939 world production of synthetic caoutchouc amounted to a total of about 75.000 tons or about 7.5 per cent of the total output. For 1960 the figures are estimated at a little over 2600.000 tons and 55 per cent, the capacity, however, being estimated to be nearly 3.400.000 tons! (See also Appendix II).

It should be mentioned that the figures for 1960-66 are substantially higher than the targets originally set in the Seven-Year Plan for the year 1965, viz. about 2½ times the 1958 output or about 575.000 tons. The capacity exceeded this level even in 1960. However, some uncertainty with regard to the figures must be allowed [redacted]

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The USSR's Import of Natural Caoutchouc shows a downward trend in recent years in spite of the increase in the consumption of rubber. The import was increasing until 1958. (1956: 140.700 tons, 1957: 145.500 tons, 1958: 260.000 tons, 1959: 242.100 tons, 1960: 167.000 tons).

The low import in 1960 has been supplemented with 50.000 tons from home stockpiles. [redacted] e

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Table 1

Production of Synthetic Caoutchouc in Tons in USSR [redacted]

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Year	USSR
1932	220
1937	...
1938	...
1939	60.000
1940	70.000
1941	24.400
1942	...
1943	...
1944	...
1945	...
1946	...
1947	39.100
1948	70.000
1949	95.200
1950	112.300
1951	...
1952	146.900
1953	166.000
1954	168.500
1955	188.700
1956	183.500
1957	211.100
1958	230.200
1959	...
	Capacity
1960	600.000
1961	750.000
1966	2.000.000

x) calculated

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[redacted] the fall in [redacted] market price of natural caoutchouc disastrously in the latter half of 1960. Nevertheless, the low price does not appear to have stimulated the demand for natural caoutchouc very much, not even on the part of the USSR.

The facts mentioned above lend support to the assumption that the USSR is now able to get along on its own, and there can hardly be any doubt that in the case of war the USSR will be self-sufficient in caoutchouc for all war purposes.

4. The USSR's Production of Synthetic Caoutchouc.

The fact that the USSR's capacity in synthetic caoutchouc production has increased tremendously appears from Table 2 (see also Appendix III). That production does not keep pace is due to delays in the raw material sector. Besides, an output corresponding to the capacity could not be sold, the production of finished goods suffers under a shortage of active fillers cord fabric, etc.

Table 2

4.1. Synthetic Caoutchouc Factories in the USSR.

Situation	Production started
JAROSLAVL	1/1 1932
VORONEZH	Sep 1932 (first part)
YEFREMOV	May 1933
KAZAN. Tatar. ASSR, name SK-4	25/11 1936
YEREVAN (developing)	1938 (1940?)
KRASNOYARSK	1957 (1955?)
SUMGAIT	1957
VORONEZH	1958 (second part)
SUMGAIT	1959 (" ")
KARAGANDA	1960
KUIBYSHEV	1960
STAVROPOL (first part completed 1962, second part 1965)	1960
STERLITAMAK (second part completed 1963, third part 1965)	1960
TEMIR TAU	1960
TAMBOV (only finished goods?)	?
(SARANSK, foundation stone laid	1/1 1960)

Several of the factories which started production in 1960 had already been planned under the third Five-Year Plan but were prevented from coming into being by the war. This applies to SUMGAIT, OMSK, TAMBOV, and TEMIR TAU, [redacted] factories in KURSK, BAKU, and KEMEROVO are probably on the programme for the near future. [redacted] synthetic caoutchouc factories are in operation at BAKU and KEMEROVO, and also at AKTYOBINSK, MAGNITOGORSK, and LENINGRAD. The combinate in construction at SARANSK is believed to be intended [redacted] for the USSR's caoutchouc industry. It is stated elsewhere that the Seven-Year Plan includes the building of 15 new synthetic caoutchouc factories, and that the equipment for such factories will cost approximately £ 1.6 million per plant.

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Among the plants mentioned, JAROSLAVL should be singled out for special attention, partly as being one of the largest in the USSR (the largest but one?) and partly as one of the most important ones with regard to the development of new types of caoutchouc.

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SUMGAIT was the first plant to use only by-products from the petroleum industry, partly via ethyl alcohol, partly direct from waste gas (n-butane). The plant at YEFREMOV is to be made fully automatic in 1965.

In order of production capacity for 1965 the factories are believed to stand thus (irrespective of types of caoutchouc):

STAVROPOL
STERLITAMAK
VORONEZH
JAROSLAVL
YEFREMOV
SUMGAIT
YEREVAN
KRASNOYARSK
KAZAN
TEMIR TAU

Changes in this order are not likely. It is based on plan figures from 1958. The newest plants could not be included for lack of information regarding their capacities.

5. Types of Synthetic Caoutchouc in the Soviet Production Programme.

Before the war the Soviet plants produced, in reality, onely one type, viz buna. In 1945 the number of different types was 6 besides 2 types of synthetic latex, in 1956 23+12, and in 1960 39+16.

Table 3

Main Groups of Synthetic Caoutchouc Types

Name	Capacity - Tons USSR 1966	
1. Styrene-butadiene caoutchouc	900.000	[redacted]
2. Isoprene caoutchouc (dien-caoutchouc)	500.000	
3. Chloroprene caoutchouc	250.000	
4. Butyl caoutchouc	100.000	
5. Nitril caoutchouc	60.000	
6. Other caoutchoucs, incl. silicone-c.	200.000	...

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5.1. Styrene-Butadiene Caoutchouc, often called styrene rubber.

This group is the most important one in the Soviet production programme. So it [redacted] will probably continue to hold its position.

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It is produced at the following plants: JAROSLAVL, SUMGAIT, STAVROPOL, STERLITAMAK, VORONEZH, and KRASNOYARSK.

This group of synthetic caoutchoucs is probably to be produced in several of the planned plants.

This group includes numerous variants, mainly characterized by varying styrene or methyl-styrene contents: (the small s in the type designations below is omitted in other reports).

Soviet type designation for styrene butadiene caoutchoucs: SsKSs-5, SsKSs-10;

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The numeral indicates the proportion of styrene. In the examples given here they are 5 and 10; they may also be 30, 50, 65, and 90.

For methyl-styrene-butadien the equivalent Soviet type names are SsKMSs-10 and SsKMSs-30.

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[redacted]

5.2. Isoprene Caoutchouc, Diene Caoutchouc (Cis - 1.4 Polyisoprene)

This group of synthetic caoutchouc was not produced on any large scale in the USSR until 1961. Its properties are similar to those of natural caoutchouc especially. It is to be expected that the USSR will be particularly concerned with this group in the future, also because it may compete with natural caoutchouc with regard to price. [redacted]

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The plants producing this group are probably: JAROSLAVL, STERLITAMAK, VORONEZH, and YEFREMOV; to these may be added several plants projected.

Soviet type designations for diene-caoutchoucs: SsKI and SsKV.

[redacted]

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5.3. Chloroprene Caoutchouc.

This synthetic caoutchouc has been produced in the USSR since 1940.

Production takes place at: YEREVAN and TEMIR TAU.

Soviet type designations for chloroprene caoutchouc: Sovpren and emulsion caoutchouc: Nairit NK, Nairit A (like gutta-percha), and Nairit S (containing 3-5 per cent styrene).

[redacted]

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Applications:

Cable insulating material, oil tubes, transport belts, and adhesive (shoe manufacturing).

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5.4. Butyl Caoutchouc.

This synthetic caoutchouc is comperatively new. The 1961 output will amount to 2000 tons. Its importance lies in its special applications which arise from its resistance to dampness and ozone (extreme resistance to ageing), its good dielectric properties in connection with its relatively high resistance to heat and its particularly high resistance to penetration by liquid war gases.

Production takes place at: YEFREMOV and SUMGAIT (1961/62?).

Soviet type designations: Not known.

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Applications: 50X1-HUM

[redacted] automobile and bicycle tubes, cable insulating material (next in importance to chloroprene caoutchouc).

A variant of particular interest is bromine-butyl caoutchouc (continue 2.5 - 3 per cent of bromine). Unlike normal butyl-caoutchouc it shows a high degree of adhesion to elastomers and to metals. Thus [redacted] made from 50X1-HUM butyl-caoutchouc, natural caoutchouc, and styrene butadiene caoutchouc cannot be combined. If, on the other hand, bromine-butyl caoutchouc is used as an intermidiary layer, butyl caoutchouc treads can be vulcanized [redacted] of 50X1-HUM natural or styrene-butadiene caoutchouc.

5.5. Nitril Caoutchouc, Polybutadiene-Acrylo-Nitril Caoutchouc.

Produced at: JAROSLAVL and SUMGAIT.

NB: It is this type of caoutchouc which is now being produced at SUMGAIT by a new method, the so-called 'one-stage' method, direct from natural gas (butan).

The quality is said to surpass that [redacted] hitherto known. The price 50X1-HUM is said to have been reduced by up to 35 per cent.

Soviet type designations for nitril caoutchoucs: SsKN-18, SsKN-26, and SsKN-40, in which the numerals indicate the nitril content.

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Applications:

All kinds of oil, petrol, and grease resistant tubes and gaskets.

5.6. Other Types of Synthetic Caoutchouc.

This group includes a number of types with some extremely important properties and applications implied thereby.

The USSR is working energetically on the development of caoutchouc types resistant within a wide range of temperatures to humidity, ozone, ultra-violet rays, acids, alcohols, oil etc., properties which are of importance to the use of caoutchouc in rockets, for instance. Only a few of such special caoutchoucs are in large-scale production. Some of them are presumably being manufactured at pilot plants in quantities sufficient large for the present, others on 'laboratory scale' in the technological laboratories of the rubber industry, or at scientific institutes (MOSCOW, LENINGRAD VNIISK, JAROSLAVL, SUMGAIT).

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The development of heat resistant caoutchoucs seems to be based principally on types containing silicone and fluorine. Acryl caoutchoucs and combinations (co-polymers) of various types, however, are also in consideration.

Silicone caoutchouc is in large-scale production at YEREVAN and VORONEZH since 1956-57.

Soviet type designations: SsKT (5r-129, 14r- .

Applications:

The applications are based on the particular properties of this type. It is resistant to: ozone, ultraviolet rays, solvents, oils etc. at temperatures ranging from ÷60°C to + 250°C. Silicone caoutchoucs are used as electric insulating materials in motors and generators, in the aircraft industry, in rockets etc.

(For comparison it may be mentioned that such caoutchoucs as the nitril caoutchoucs (SKN) and styrene-butadiene caoutchoucs (SKS) retain a high mechanical strength only at temperatures between ÷35°C and +150°C).

Fluorine caoutchoucs are being manufactured, the place of manufacture, however, is not known.

Soviet type designations: FKS-1, FKS-2, and FKS-3 (the numerals refer to the content of inorganic fillers, 55 per cent, 45 per cent, and 33 per cent respectively). Applications as above, but higher heat resistance.

It seems to be the properties of FKS which are best suited to such applications as gaskets (packing materials), insulating materials for electric equipment in rockets, jet aircraft etc. The range of temperature is stated to be from ÷70°C to +350°C and for shorter periods (up to ten hours) it is said to be up to 400°C. The production of FKS armoured with glass fibre is being developed-

No accurate information has been found available regarding the chemical composition of the FKS caoutchoucs, the nature of the fillers in the finished rubber product and the methods of vulcanization used.

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[redacted]

There is good reason, therefore, to observe possible motives behind the interest shown by the USSR in this group of synthetic caoutchoucs.

Polyurethane caoutchouc, isocyanate caoutchouc is in production but no information as to the place of production has been found. (Its development is conducted by the scientist N.P. APUKHTINA).

This type of caoutchouc is particularly resistant to ageing, ozone,oil, ultraviolet rays, solvents, and wear. It is also particularly gas-proof.

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6. SUMMARY

The synthetic caoutchouc industry of the USSR has attained to a very high capacity which is still increasing. The output has not been of similar magnitude owing to a shortage [redacted] to operate the plants, and the continuous repairs to be carried out in consequence of this shortage. Another reason, not the least important, is the failure of raw materials, qualitatively as well as quantitatively. Since 1958, however, the quality of most caoutchoucs has been considerably improved - though perhaps unequally, in consequence, among other things, of great variations in the purity of the raw materials.

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There can be no doubt that the Soviet industry would be able to meet the demand for new caoutchoucs for all military purposes. In addition, increasing amounts of regenerated caoutchouc are made from rubber waste of every discription [redacted]. It must be assumed that an increasing proportion of the caoutchouc output is already being used for military purposes, possibly emergency stockpiles, seeing that the civilian consumption does not increase in tune with the increase of production.

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There are signs that the USSR has started to draw on its emergency stockpiles of natural caoutchouc. This may be due to a fall in the demand in consequence of the growing production of synthetic caoutchouc.

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It is not unthinkable that the stockpiles are to be made up of finished goods to a greater extent, as synthetic caoutchouc is gradually being made better suited to storing. A constant import of natural caoutchouc can be explained by political motives i.e. trading with caoutchouc producing countries.

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7. **NOTES**

By synthetic caoutchoucs - or better perhaps - synthetic rubber is meant substances synthetically produced which irrespective of their chemical composition come near to natural rubber or caoutchouc as to physical properties. In other words, they are elastic - in som cases after being vulcanized. They are highly extensible, and resume their original shape on being relaxed.

Synthetic caoutchoucs are, according to their composition and the process by which they are formed, plastics, sub-group: vulcanizable elastomeric plastics.

Caoutchouc is made up of giant molecules in which the monomer (low-molecular) compounds are repeated often several thousand times into the high-molecular compound of caoutchouc.

In principle the productive process is a polymerization, a chemical reaktion between identical molecules of monomeric compounds.The process is usually spontaneous, but is promoted by temperature increases and by the action of catalysts.

Thus, for instance,the monomer compound styrene is polymerized into polystyrene.

Polymerization of a blending of two different monomers is called co-polymerization. For example, a blending of the monomers styrene and butadiene produces a polybutadienestyrene, e.g. buna or GR-S.

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As to catalysts the following points should be noted. For the synthetic chemical industry catalysts are of the greatest importance. They do not, in principle, constitute a part of the compounds formed, but they promote the chemical processes merely by their presence. The synthesis of polyethylene may be mentioned as an example. This plastic may be produced under pressures of 1000-1500 atmospheres (the so-called high-pressure polyethylene). By the presence of a catalyst the pressure may be reduced to 1 atmoshere (several methods require 20-50 atmospheres). Thus the so-called low-pressure polyethylenes are obtained. Other processes in which catalysts are not used require very high temperatures, or both high temperatures and high pressures. Soviet chemists are working hard at the development of the catalysts method seeing that may facilitate and reduce the cost of many processes.

The plants can be made cheaper and the output may be increased to the theoretically greatest possible extent. The research that is being made in the USSR in this field deserves attention.

By vulcanization is meant the processby which caoutchouc is converted from the plastic to the elastic, rubber-like statewhether this is done by means of organic or inorganic vulcanizers or by means of gamma rays with or without the use of 'accelerators'. (Among scientists that have done research in this field the Russian B.A. DOGADKIN, MOSCOW, is particularly prominent).

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Vulcanized materials and the finished goods [redacted] have certain tendency to ageing, which means that the rubber becomes tender through the influence of oxygen, sunlight and ozone. To counter this tendency small quantities of antioxydants, also called antioxygens are added, especially to such vulcanized products which are required to resist heat and particularly strong mechanical influences [redacted] and long-time storage (emergency stockpiles [redacted]

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The mechanical properties are improved by the addition of various <u>fillers</u> which may be of decisive importance for the application of the vulcanized materials. To the <u>active</u>, reinforcing fillers belongs the so-called <u>carbon-black</u>, a kind of soot, which is used in quantities amounting to about 50 per cent [redacted] Large quantities of carbon-black are thus required, 50X1-HUM and the USSR is greatly expanding this production by building new factories and by automation of the plants, e.g. in KADIYEVKA, JAROSLAVL, OMSK (operating since July 12th, 1959; to be completed 1965), AKTYOBINSK (begun in 1960), and CHIMKENT (begun in 1960). Other carbon-black factories may be mentioned, e.g. MAYKOP, BAKU, KUDINOVA, and URITSK. Carbon-black is often named after the method of production as: lamp-black, channel-black, furnace-black, therma-black etc.

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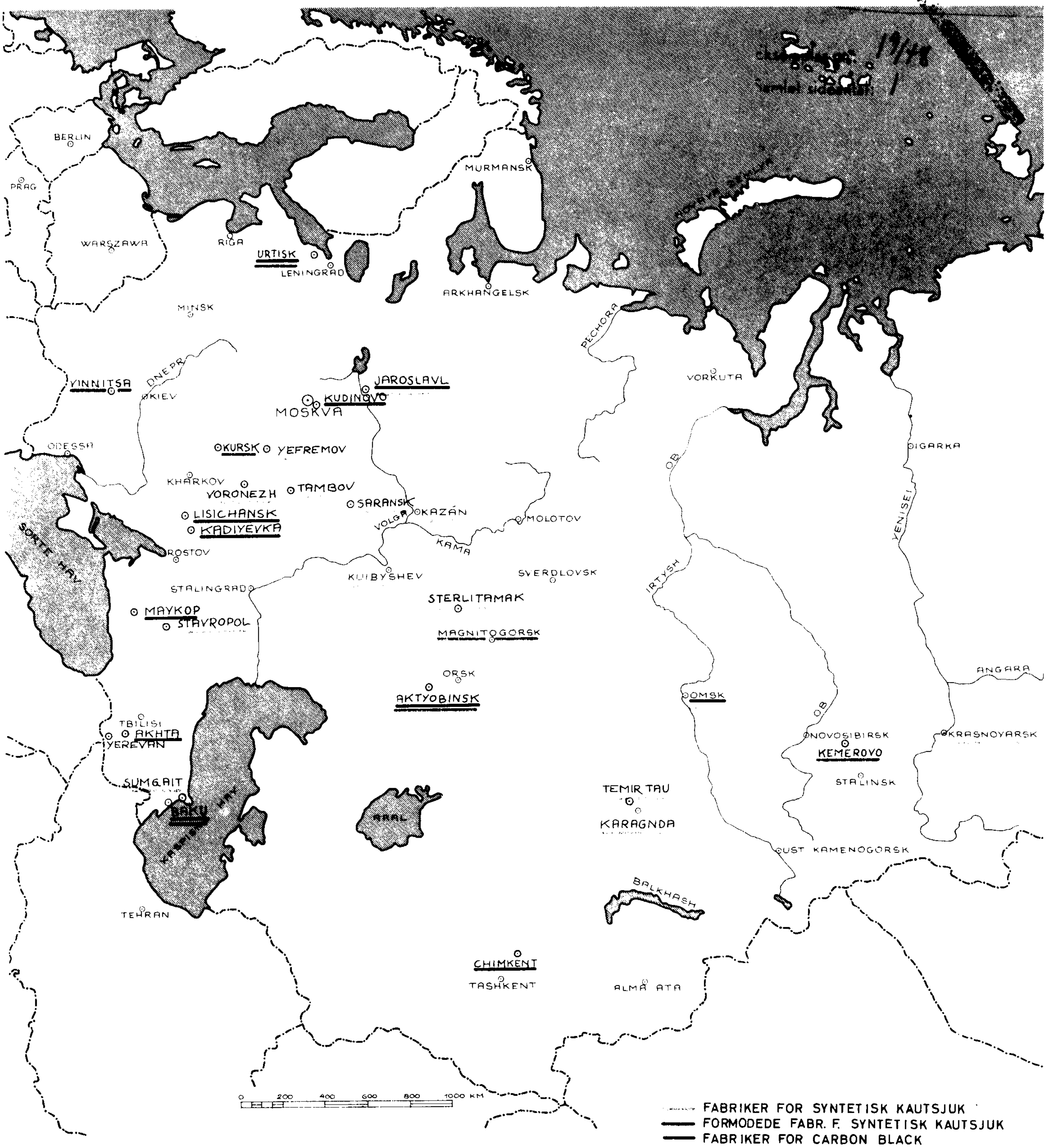

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