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NEW TECHNOLOGY IN THE SOVIET CHEMICAL INDUSTRY DURING THE SEVEN YEAR PLAN (1959–65)

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FOREWORD

As part of the Seven Year Plan (1959-65) for development of its chemical industry, the USSR has planned widespread introduction of automation and mechanization, along with a number of other measures intended to increase efficiency. Conditions inherent in production of most present-day chemicals favor the application of advanced automation and mechanization. The production cycle is often expedited by the use of continuous processes, and stringent demands exist for the control of processes because of the requirements for high purity of products and the danger of fire, explosion, or poisoning of the atmosphere. In addition, the necessity for handling large amounts of bulky materials, both raw and finished products, places a premium on the development of laborsaving devices for loading and unloading and for weighing and packaging of materials.

The purpose of this report is to discuss the details of the various programs for technical advance in the Soviet chemical industry during the Seven Year Plan, indicating wherever possible the anticipated savings in capital or labor, the degree of progress in implementing these programs during 1959-61, and the expected improvements by the end of the Seven Year Plan.

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NEW TECHNOLOGY IN THE SOVIET CHEMICAL INDUSTRY DURING THE SEVEN YEAR PLAN (1959-65)*

Summary and Conclusions

The USSR is engaged in an ambitious program to triple gross production of chemicals during the Seven Year Plan (1959-65). To minimize the capital and labor requirements for this expansion program, and also to improve the quality of output of the industry, the USSR has adopted a number of measures calculated to increase the efficiency of its chemical processing. These measures include conversion to a new raw materials base (petroleum and natural gas), adoption of more modern production processes (partly by purchase of technology from the Free World), improvement in the design of chemical facilities, and widespread introduction of automation and mechanization.

Of the total planned investment of 10.0 billion to 10.5 billion rubles** in the Soviet chemical industry in 1959-65, investment in automation is scheduled to be from 0.2 billion to 0.4 billion rubles. In 1959-61, progress toward the goal appears to have been only modest. Some success, however, was reported in the automation of plants producing synthetic alcohol, nitric and sulfuric acids, ammonia, synthetic rubber, alkali products, and styrene. The use of computer control is still quite limited, and more widespread application of computers is being hampered both because Soviet automation specialists lack sufficiently detailed knowledge of chemical processes and because measuring devices now available to the chemical industry are often of inadequate quality and reliability to provide good process control using standard procedures, much less advanced computer-control techniques. Considerable Soviet interest has been evinced in the future use of computers for designing model-scale plants in order to facilitate the transition from laboratory to production on a commercial scale, a transition that is at present a major bottleneck.

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* The estimates and conclusions in this report represent the best judgment of this Office as of 1 November 1962.

** Ruble values in this report are given in new rubles established by the Soviet currency reform of 1 January 1961. A nominal rate of exchange based on the gold content of the respective currencies is 0.90 ruble to US $1. This rate, however, should not be interpreted as a precise ruble-dollar relationship that will yield an equivalent dollar value for the ruble.

In addition to the emphasis on automation, the USSR is devoting considerable effort to the mechanization of chemical plants, although results are as yet modest in comparison with the need. Thus manual labor accounts for about 40 percent of the total labor requirements in production of Soviet chemicals.

As with automation and mechanization, Soviet adoption of improved chemical processes also was quite limited in 1959-61, although it is claimed that better processes have been developed for production of certain types of synthetic rubber, fibers, and plastics. Lags in development of a number of chemical products have been admitted, including development of durable tire cord, improved fertilizers and pesticides, and certain of the newer types of synthetic rubber.

Difficulties encountered in accelerating development of the chemical industry have spurred efforts by the USSR to purchase technical data and advanced equipment from the West. In 1958-61 the USSR contracted for the purchase of more than 50 complete chemical plants from the West, and further purchases are likely in view of the continuing difficulties in domestic development and production of chemical equipment.

In further support of the program for rapid technological development, the State Committee for Chemistry has undertaken a rapid buildup of its research and planning institutes. The number of workers in planning institutes of the State Committee reached 19,000 by the end of 1960, more than double that in 1957. In spite of this increase, however, the operation and organization of these institutes is far from ideal, and shortages of technically qualified personnel persist.

The failure of the Soviet chemical industry to meet investment goals in the first 3 years of the Seven Year Plan has been caused in part by the continuing difficulties associated with the development and mastery of new processes and equipment. Technical changes for the next few years probably will continue to be introduced more slowly and often at greater cost than anticipated by Soviet planners. As a result, the goals for 1965 for priority chemical products such as fertilizers and plastics are unlikely to be met, and increases in productivity probably will be less than planned. Even the limited adoption of modern processes and cheaper raw materials, however, should permit considerable savings in the production costs of the Soviet chemical industry, and improvements in the quality of products such as motor vehicle tires will provide additional savings to the Soviet economy. These technical changes, moreover, should facilitate the continued rapid expansion of the Soviet chemical industry scheduled through 1980.

I. Introduction

The USSR is in the midst of an ambitious program to triple gross production of chemicals in 1959-65, with heavy stress on both the construction of new facilities and the expansion and modernization of existing ones. At present the Soviet chemical industry, although the second largest in the world, does not adequately meet the requirements of the Soviet economy, and operation of the industry is inefficient by Western standards, being characterized by batch processes and large inputs of manual labor. For example, labor productivity in the Soviet cellulose industry reportedly is 42 percent of that in the equivalent US branch of industry, while productivity in the sectors of the chemical industry producing synthetic rubber and artificial fibers is said to be 18 and 19 percent, respectively, of that in the US. 1/* To alleviate such shortcomings, the USSR is stressing the adoption of technological measures with a heavy orientation toward economy in the use of labor. The introduction of new technology is scheduled to provide a greater share (71 percent) of the planned increase in labor productivity in the chemical industry than in Soviet industry at large (50 percent). 2/ Mechanization** is to be increased in the mining of chemical raw materials and in plant operations involving the handling of large amounts of raw and finished materials. Fully automatic continuous processes are scheduled to replace batch processes in order to assure higher yields and greater uniformity of end products and to minimize inputs of raw materials and labor. In addition, the industry is scheduled to effect a radical shift to the use of petrochemicals*** and to improve the design of new chemical facilities in order to achieve savings in capital and to utilize byproducts more efficiently.

II. Plans, Progress, and Problems Relating to the Introduction of New Technology

A. Automation†

In contrast to the US, where automation is applied extensively in the chemical industry, the present status of automation in the Soviet

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** For the purposes of this report, mechanization may be defined as the substitution of machines for direct labor by human personnel.

*** The term petrochemical is used in this report to refer to primary or basic chemicals obtained from petroleum or natural gas. Examples include acetylene, ethylene, and propylene.

† As used in Soviet literature, the term automation is sometimes ambiguous but generally refers to the use of automatic processing units or some form of automatic production system. The Soviet authorities distinguish three levels or degrees of automation: partial, complex, and full. See also the second footnote on p. 4, below.

chemical industry is characterized by a great deal of partial automation that is neither coordinated nor so productive as it could be. To a large extent this lag has resulted from the inadequate variety and quality of the instruments being produced and from the frequently inferior process design work. In addition, much of the present equipment is not adaptable to automatic control. In the new plans for automation, priority has been assigned to developmental work mainly on those chemical processes that are most labor-intensive.

Investment data provide some indication of the significance of the plans for automation during 1959-65. Of the 10.0 billion to 10.5 billion rubles that are to be invested in the industry, expenditures for automation are to be from 0.2 billion to 0.4 billion rubles,* reportedly comprising 9 percent of the total investment in equipment for the chemical industry. 5/ In contrast, expenditures for automation of chemical plants in recent years generally have not exceeded 1 to 3 percent of the total cost of equipment. 6/

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More than 150 shops and production processes reportedly will be automated.** Priority is being given to automating production of petrochemicals, synthetic materials (rubber, fibers, and plastics), fertilizers, alkali products, dyes, and alcohol. Plans for 1965 call for production of synthetic rubber and synthetic alcohol to be fully automated, production of plastics to be 95 percent automated, and production of synthetic fibers to be 90 percent automated. Model automated plants are to be established at Voronezh, Lisichansk, Novomoskovsk (formerly Stalinogorsk), and Barnaul.

Soviet writers have not published comprehensive data on the expected effect of implementation of the automation program. Some partial data are available, however, that appear to apply to the effect of automation on those segments of the chemical industry which are to be automated. Thus it is stated that automation will increase output by 5 to 8 percent, increase the productivity of labor by at least 30 percent,***

* The USSR has published two figures that relate to planned investment in automation, one giving a range of 0.2 billion to 0.25 billion rubles, 3/ the other stating that more than 0.4 billion rubles will be invested in instrumentation and means of automation. 4/ The higher figure may be the more valid one in view of the ambitious plans.

** The degree of automation intended is not known, although a Soviet report suggests that automation in the chemical industry may occur in three stages, proceeding from automation of individual processes or units of equipment through automation of the complete production process to centralized control of the entire enterprise. 7/

*** A Soviet article states that automation of plants producing synthetic rubber, alcohol, and artificial fibers will increase the productivity of labor 40 percent in these areas by 1965. 8/

lower the cost of production by 10 to 15 percent, and decrease the number of service personnel by 15 to 20 percent. 9/ The laborsaving effect is noteworthy and consistent with the priority given to automating labor-intensive processes.

Soviet achievements thus far in automating the chemical industry appear in sharp contrast to the plans. [redacted] progress seems to have been limited to partial automation of some of the plants producing synthetic alcohol, nitric and sulfuric acids, soda ash, caustic soda, and styrene, and one fully automated nitric acid plant was reported to be operating in November 1961 at Dneprodzerzhinsk. 10/ 50X1

As one might expect from the slow introduction of automation, computers are not widely used in the Soviet chemical industry. In September 1961 the chief engineer of the Experimental Design Bureau of Automatics of the State Committee for Chemistry reported that "we need machines -- the talk that computers are ready does not correspond to reality," adding, "therefore, we cannot discuss a broad application of computing machines to the chemical industry." 11/ On a limited scale, however, the use of computers of the Mars type* has been initiated at synthetic rubber plants at Voronezh and Yefremov and at rubber fabricating plants in Moscow. An elaborate computer is being developed by the Moscow Power Institute for the Voronezh rubber plant, one of the scheduled model automated plants of the chemical industry. The new computer allegedly will control the technological process for production of synthetic rubber, including the auxiliary services, as a single interrelated complex. 12/ A computer is in use at the fertilizer plant at Novomoskovsk, another enterprise planned to be a model of automation. In a recent experiment in remote control a computer at the Ukrainian Academy of Sciences regulated the operation of a unit at the Slavyansk Soda Combine, 630 kilometers distant. The experiment may be related to a Soviet plan to create single computation centers for several industrial enterprises of a given region, on the theory that the existing individual installations cannot utilize the full potential of the new computers.

Among the impediments to the broader use of computers in the Soviet chemical industry (and in the West as well) is the insufficiently detailed knowledge of many chemical processes, which limits the possibilities for developing mathematical expressions of these processes, a prerequisite to the efficient use of computer control. In addition, present measuring devices available in the USSR reportedly do not supply sufficient information to assure the most effective control of the composition

* A class of Soviet computers with various designations, depending on the number of points to be monitored. The Mars-300, for example, conducts automatic registration and signalization of 300 points of a technological process.

and quality of products. 13/ Although these weaknesses suggest that computer control will continue to be introduced slowly in plants of commercial scale in the USSR, considerable Soviet interest has been expressed in the use of computers to speed the transition from laboratory to commercial production by aiding the design of model-scale plants and equipment. It is precisely these areas that have contributed to much of the lag in development of new chemical products in the USSR, so that the increased use of computers for such purposes can be quite significant in the future development of the chemical industry.

B. Mechanization

The level of mechanization in the Soviet chemical industry is extremely low, and considerable savings of money and manpower are possible if operations such as loading and unloading, charging of raw materials into reactors, and weighing and packaging of materials are mechanized. A Soviet article comparing the periods of time required to recoup investment in mechanization in several major industries showed that such investment was recouped most rapidly in the chemical industry. 14/ At present, manual labor reportedly accounts for about 40 percent of the total labor requirements in production of Soviet chemicals, with more than 15 percent of all Soviet chemical workers engaged in materials handling operations. 15/ The USSR is devoting special emphasis during the Seven Year Plan to mechanizing the mining of chemical raw materials such as sulfur and apatite, as well as mechanizing production of basic chemicals and fabricated rubber and plastics products. Reportedly, 100,000 workers in the chemical industry will be available for other tasks if the level of mechanization planned for 1959-65 is attained. 16/

Some progress has been reported in mechanizing Soviet plants during 1959-61, including those producing molded industrial goods and tires, alcohol, and butadiene, but difficulties in this area persist. In a new tire plant in Baku, for example, 80 percent of the conveyors intended for intraplant movement of raw materials were not yet operating as of January 1962, although the plant had started up in 1959.

C. Process Technology

Many of the new chemical processes planned for introduction by the USSR in 1959-65 envisage the use of petrochemicals, although these materials found only limited application in the Soviet chemical industry until recently. The Seven Year Plan calls for the chemical industry to use about 2.5 million tons* of liquid hydrocarbons derived from gas in 1965. In the USSR in 1965, 55 percent of the total production of ammonia is scheduled to be made from petrochemicals, as is 95 percent of production

* Tonnages are given in metric tons throughout this report.

of synthetic rubber, 66 percent of that of phenol, 93 percent of that of caprolactam, and the entire production* of polyethylene and polyvinyl chloride. 17/ According to a Soviet source, the creation of large petrochemical facilities would permit a reduction of at least 15 to 20 percent in the cost of producing many chemicals. 18/ As an additional source of basic materials, the chemical industry plans to exploit more of the valuable components of its raw and waste materials than hitherto, and this trend will promote the development of large multiproduct complexes. For example, further exploitation of the natural gas at nitrogen fertilizer plants will lead to combining production of ammonia with products such as acetylene and alcohol.

In addition, the Soviet chemical industry is advocating the adoption of other improved chemical processes, particularly the substitution of continuous processes for batch processes and the construction of plants with larger unit capacities.** To illustrate the latter point, polyethylene plants built during the Seven Year Plan are now scheduled to have unit capacities of 24,000 tons or more, although plants with capacities of 5,000 to 20,000 tons were scheduled during the preliminary work on the plan.

During the first 3 years of the Seven Year Plan the USSR made some progress in the development and introduction of new chemical process technology. In the petrochemical field the use of natural or refinery gas was initiated in production of ammonia at Novomoskovsk, Chirchik, and Salavat; in production of synthetic rubber at Sumgait, Stavropol', and Sterlitamak; and in production of ethyl alcohol at a number of installations. In addition, the USSR has claimed completion or near completion of development work in the following areas: continuous processes for production of synthetic rubber, caprolactam,*** cellulose triacetate, polyvinyl chloride, bakelite resins, and polyvinyl alcohol; an improved process for production of acetaldehyde eliminating the use of mercury; and a fluidized bed process for production of sulfuric acid. Also, moderately extensive developmental work appears to be underway on the use of radiation in processes such as polymerization and vulcanization of polymeric materials.

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* Petrochemical raw materials would not necessarily be the sole ingredient in these chemical products but would be used to provide at least one component of the finished product.

** The USSR may be considering a modification of its goal for developing plants of large capacity in the case of some fertilizer facilities. [redacted] ammonia plants of medium capacity (50,000 to 100,000 tons per year) may be built near areas of consumption. 50X1

*** An intermediate used in production of Nylon-6.

In spite of the reported achievements, it is apparent that the rate of the development of new chemical processes demanded by the Seven Year Plan has not been approached. A conspicuous lag in the introduction of petrochemicals has been in production of acetylene. An installation using natural gas to produce acetylene allegedly went into operation at Saratov in 1959, but a report of November 1961 revealed that no useful output had yet been obtained. 19/ Similarly, delays have been encountered in working out processes for production of more durable tire cord, polyisoprene rubber,* pesticides and herbicides, synthetic glycerine, and a number of other products. There is reason to suspect, moreover, that the existing pace is already too fast for rational development in some areas and that the USSR has introduced processes which still embody serious defects. For example, a continuous process for production of nitrile rubber introduced at Sumgait yielded such poor results that the unit was subsequently dismantled. 20/ At a new ammonia shop at Lisichansk the percent of conversion of ammonia into useful production reportedly was far below that of an old shop which had been operating for 10 years. 21/

Part of the delay in introducing new process technology in the Soviet chemical industry can be attributed to weaknesses or difficulties in the manufacture of chemical equipment. Production of chemical equipment in general has been inadequate to meet the demand, and the shortage has been most severe in the newer types of equipment. Underfulfillment of plans for the creation of capacity for production of new equipment has been the principal cause of the shortage. More than one-third of the new capacity for production of chemical equipment planned for introduction in 1960 failed to go into operation. 22/ Other factors also have contributed to the shortage. Production of chemical equipment has been hampered by haphazard planning that has been reflected in shortages and late deliveries of input materials, such as special steels and alloys, clad metal, ceramics, and tantalum. 23/ The shortage of equipment, and particularly the shortage of newer types of equipment, has been aggravated further by the tendency of Soviet producers to concentrate on production of more easily manufactured items at the expense of more critical items. The existing design facilities, moreover, have not been able to keep pace with the large demand for new and more modern equipment, partly because poor planning by the chemical industry itself has resulted in changes of plans, causing frequent cancellation of orders and redesign of equipment. 24/

Because of the difficulties experienced in expanding and modernizing its chemical industry, the USSR has resorted to large-scale purchase of chemical technology and equipment in the Free World. In 1958-61 the

* A relatively new type of synthetic rubber with a potential for use as a complete substitute for natural rubber.

USSR contracted to purchase more than 50 chemical plants from non-Bloc countries, with many of the installations embodying advanced concepts of automation and mechanization and some permitting production by petrochemical processes. In some sectors of the chemical industry, particularly those producing viscose cellulose, fibers, polyethylene plastic, and motor vehicle tires, the purchases constitute a rather sizable part of the planned increases in production. In other fields, such as synthetic rubber and fertilizers, purchases do not appear to have been sufficiently extensive to overcome the domestic lags in development. In the case of certain products such as synthetic rubber, Western trade controls appear to have blocked or retarded Soviet acquisition of advanced processes.

In addition to the purchase of Western technology, the USSR is obtaining chemical technology and equipment from the European Satellites, in part through the mechanism of the Council for Mutual Economic Assistance (CEMA). Joint efforts undertaken by the Soviet Bloc to speed the development of automation in the chemical industry include but are not limited to the following fields: production of butadiene-styrene rubber (the USSR and East Germany), the electrolytic production of chlorine (the USSR, East Germany, and Czechoslovakia), and the use of radioisotopes in measuring and regulating instruments (the USSR and Hungary). 25/

D. Research and Planning Facilities

To evaluate more accurately the program for rapid technological development of the Soviet chemical industry, it is important to understand the present composition and functions of the State Committee for Chemistry, which is attached to the Council of Ministers, USSR. The State Committee appears to have major responsibility for the introduction of new technology in the chemical industry, with some technical support from the Academy of Sciences and from a number of other organizations outside the direct jurisdiction of the chemical industry. The State Committee is composed of a number of functional main administrations (such as the Main Administration of Tires and Rubber Technical Articles) and technical and planning institutes. Each planning institute, while directly subordinate to the State Committee for Chemistry, is guided primarily by the corresponding Main Administration.* The Main Administration coordinates the activity of the planning organizations with the work of the research institutes, monitors the progress of construction of chemical enterprises, regulates the release of technical documentation, and adopts decisions to introduce new processes or equipment.

* For a discussion of the multisubordination of planning institutes within the State Committee, see p. 10, below.

A rapid buildup of the chemical research and planning institutes within the State Committee has been underway since 1958. In 1959 and 1960, 8 new scientific research institutes and 34 branches of institutes and design organizations were established in centers of the chemical industry. 26/ The number of workers in planning institutes of the State Committee rose from 8,000 in 1957 to 19,000 by the end of 1960. 27/ In addition, about 10,000 people from subcontracting organizations of other branches of the economy work on special parts of the plans for the chemical industry, making a total of almost 30,000 so engaged. 28/

In spite of the rapid buildup of the technical and planning institutes of the State Committee for Chemistry, frequent criticism is voiced in the Soviet press because of their continued espousal of technically outdated processes, because of delays in the provision of documentation, and because of alleged defects in the very organization of the institutes. A shortage of technically qualified workers is apparent in spite of the rapid increase in personnel. Only 2 percent of the workers in scientific research institutes of the State Committee reportedly are engaged in work on automation and almost half of the institutes have no specialists on automation. 29/ Some of the institutes are organized along the narrow product lines of the former Ministry of the Chemical Industry, and this arrangement has complicated support of the multiproduct chemical complexes now under construction, particularly because communication problems emerge when a dozen or more different organizations in widely separated geographical locations must be contacted in reference to a single construction project. Some scientific research institutes, moreover, are still performing parallel functions in the planning of gas separation processes, processes operating under high pressure, and processes for production of important products such as polyethylene plastic. 30/ This dispersal of authority often results in different technical decisions being made on the same process, ultimately delaying the adoption of new processes. An organizational weakness of the planning organizations stressed in a recent Soviet article is that of multisubordination, which creates a certain amount of overlapping control. 31/ For example, the planning organizations of the State Committee are responsible not only to the product-oriented main administrations noted above but also to the Administration of Planning and Capital Construction, to the Financial and Accounting Department, and to the Planning and Economic Administration.* In addition, some of the major institutes also are subordinate to the Technical Administration of the State Committee.

III. Probable Effects of the Program for Technical Change in the Chemical Industry

Although the negative features of forced growth have been very pronounced in the chemical industry in the first half of the Seven Year Plan,

* These three organizations are all in the State Committee for Chemistry.

the emphasis on automation and mechanization and on the introduction of new products and processes, the magnitude of the planned shift in the raw materials base of the industry, and the rapid buildup of scientific and technical support strongly suggest that some improvement in efficiency will be achieved by 1965 and that progress toward the attainment of a modern and diversified chemical industry will be more rapid than that experienced hitherto. The tentative nature of the over-all plans for introducing new technology and the generally dynamic nature of the chemical industry preclude a very precise estimate of what will be achieved, but it is possible to predict the likely trend in reduction of operating and capital costs and in improvement of quality* by 1965 and to relate the program for technical advance to the possibilities of plan fulfillment for some of the high-priority products.

A. Effects on Cost

Actual savings in the cost of producing Soviet chemicals in 1965 probably will be considerably less than anticipated in the original plans, because such technical changes as are introduced will frequently be tardy and more expensive than was foreseen. In 1959 and 1960 the reduction in production costs of chemicals in the USSR per ruble of commodity output was about 1 percent annually,** whereas the comparable reduction for all industrial goods was about 1.7 percent. 32/ The factors most likely to result in savings in cost in the Soviet chemical industry by 1965 are discussed below.

1. Changes in the Raw Materials Base and Introduction of New Processes

The substitution of petroleum and natural gas for conventional raw materials such as coke and edible agricultural products should provide substantial savings in cost in certain branches of the Soviet chemical industry by 1965, although the program is unlikely to be implemented in full. [redacted] the use of petrochemical raw materials in the chemical industry was to permit a saving in investment costs of 650 million rubles in 1959-65,*** about 80 percent of which apparently would result from reduced costs for construction of plants producing synthetic rubber and nitrogen fertilizers.† 34/ 50X1

* Actually there is some overlapping in the consideration of reduction in cost and in improvement of quality, for the latter in effect often results in a reduction in cost, but for ease of presentation the two subjects will be discussed separately.

** In comparable prices.

*** A concomitant annual saving of 130 million rubles in operational outlays also is planned.

† The investment per ton for creating new ammonia capacities in 1959-65 is planned to be only 60 percent of the equivalent level in 1951-55. 33/

A reduction in unit investment costs apparently is being realized in the case of the nitrogen fertilizer plants, but unit investment costs for synthetic rubber plants, contrary to plan, have actually been rising. 35/ Part of the anticipated savings obtained from the use of petroleum and natural gas is to result from lower manpower requirements compared with the use of alternative raw materials. For example, production of ethyl alcohol and fatty acids from petrochemicals instead of edible agricultural products reportedly will permit a saving of more than 450 million man-hours in 1965. 36/

Apart from petrochemicals, other new or improved chemical raw materials should yield significant savings to the USSR by 1965. For example, the use of chemical fibers (such as cellulose and nylon) instead of cotton* in production of tire cord, together with improved types of carbon black and synthetic rubber, allegedly will permit a radical improvement in the life of Soviet motor vehicle tires by 1965, with a resultant saving of 600 million to 700 million rubles in investment costs and 800 million rubles in operational outlays during the Seven Year Plan. 38/ Again, the actual savings probably will prove more modest because of the slow progress in improving the life of tires in the first 3 years of the plan.

In addition to the improved raw materials, the introduction of more modern processes or equipment unquestionably should provide some reduction in the cost of producing Soviet chemical products, particularly products such as fibers, plastics, carbide, and acetylene.** As noted, some of the better processes will be obtained through purchases of Western technology rather than as a result of native Soviet development.

2. Cost Savings by Automation and Mechanization

Automation and mechanization may be expected to provide some reductions in the cost of producing Soviet chemicals, particularly by increasing labor productivity and by permitting the more efficient use of raw materials, but the short-term savings by automation probably will be offset to a considerable degree by the increased cost for instrumentation. On the other hand, mechanization of labor-intensive operations in the mining of apatite and sulfur, in the loading and unloading of bulky products such as soda ash, and in the fabrication of industrial rubber articles and

* Cotton cord accounted for about 50 percent of all tire cord in 1958 but is scheduled to account for only 9 percent of such cord in 1965. Reportedly the increased use of viscose and nylon cord will save more than 90 million man-hours in 1965. 37/

** For indications that progress in mastering some of the new processes may be slower than anticipated, thus tending to modify expected reductions in cost, see p. 8, above.

motor vehicle tires should provide substantial short-run savings in the chemical industry. The highly mechanized Dnepropetrovsk Tire Plant, supplied by a Western firm, reportedly will permit an hourly output of about 54 pounds of finished product per worker compared with 48 pounds per worker obtained in leading US tire plants. 39/ The increase in productivity above that in the older Soviet plants is apparent from a report showing that the average hourly output per worker in the Soviet tire industry was only 33 pounds as of 1959. 40/

3. Increased Scale of Output

The trend to larger or more productive individual production units to gain economies of scale by spreading overhead and capital costs over a greater volume of output should be quite evident in the Soviet chemical industry by 1965, particularly in production of synthetic rubber and plastics, alkalis, fertilizers, chemical fibers, tires, petrochemicals, and certain industrial gases such as oxygen. The increase in the scale of output reportedly is to be responsible for 13 percent of the planned increase in the productivity of labor in the chemical fiber industry.* 41/

An increase in the scale of output at a fairly modest cost can be achieved in production of synthetic rubber at the newer Soviet plants by using an oil-extension process.** Reportedly the new synthetic rubber plant at Sterlitamak produces an improved oil-extended rubber. Although some oil-extended rubber also is produced at one or more of the older Soviet plants, it is doubtful that sizable economies can be obtained in the immediate future by a further changeover to oil extension at the older plants, because many of them still produce the inferior sodium-butadiene rubber that apparently is not so amenable to oil-extension as butadiene-styrene copolymer rubbers. Oil-extension probably will be used at more of the older plants by 1965, however, after they start producing the newer types of rubber.

B. Effects on Labor and Capital Productivity

Although the costs of production are expected to decline and although total productivity is expected to rise, divergent trends probably will occur in output per unit of individual factors of production. The productivity of labor undoubtedly will increase. A labor productivity

* Productivity of labor in the Soviet chemical fiber industry is scheduled to increase 60 to 70 percent during the Seven Year Plan.

** Certain oils can be added to copolymer (butadiene-styrene) rubber to extend the amount of rubber produced. In addition, these oil-extended rubbers have a lower heat buildup than conventional types and thus have a favorable effect on the life of tires.

target has not been announced for the chemical industry in the Seven Year Plan, but in view of the ambitious nature of the plans for laborsaving innovations it is probable that the increase in productivity is planned to be at least equal to the 45 to 50 percent scheduled for all industry.* The actual increase in labor productivity probably will be somewhat lower than this, however, because of the lag in introducing new technology. In 1959 and 1960 the increase in labor productivity in the chemical industry lagged behind that of all industry.

In contrast to the expected increase in labor productivity in the chemical industry, a decline in capital productivity probably will take place. The planned investment of 10.0 billion to 10.5 billion rubles in the chemical industry in 1959-65 is expected to yield an increase of about 9.5 billion rubles in the gross value of chemical output.** In the previous 7-year period an equivalent investment of about 2 billion rubles in the chemical industry yielded an increase of more than 3 billion rubles in the value of gross output.*** Thus it would appear that more capital is planned to be invested in the chemical industry during the present Seven Year Plan per unit of added output than in the previous 7-year period.† This development is in part a reflection of the shift to more

* The planned increase in labor productivity in the branch of the chemical industry producing fibers is 60 to 70 percent and in the branch producing tires, 55 percent. 42/ In spite of the probable large increase in labor productivity planned for the chemical industry in 1959-65, however, the scheduled tripling of chemical gross output should result in a significant increase in total employment in this industry above that in 1958, when the labor force is believed to have amounted to about 700,000. The increase in the labor force should be apparent even if the production goal is not fully achieved.

** It is estimated that the plan for 1965 calls for the value of gross output of the chemical industry to be 2.8 times that in 1958, and therefore it is estimated that the Seven Year Plan calls for the total value of output of the Soviet chemical industry in 1965 to be about 14.8 billion rubles compared with 5.3 billion rubles in 1958. The figure for 1958 was computed from a Soviet report on the value of gross output in chemicals in 1955, 43/ on the basis of the officially reported annual increases for subsequent years.

*** That is, the increase in the value of output in 1958 compared with that in 1951. The estimate was made on the basis of annual percentage increases in gross production, 44/ plus the Soviet report on the absolute value of gross production in the chemical industry in 1955. 45/

† According to a recent text on productivity trends in the US, 46/ long-term savings in capital per unit output were achieved in the chemical industry in spite of the substitution of capital for labor, but the study showed that in certain periods of the industrial development output per unit of capital declined. Thus the present trend in the Soviet chemical industry may well show different characteristics over more extended periods of time.

capital-intensive processes not offset by some of the capital-saving innovations previously described, such as the use of larger production units and more compact plant layouts. In addition, the decline in capital productivity probably is being caused by a higher rate of replacement of obsolete equipment than in the past and by the emphasis on construction of a large number of new plants.

C. Effects on Production

1. Improvements in Quality

Some of the factors that will contribute to the reduction in capital or production costs in the Soviet chemical industry will simultaneously result in an improvement in the quality of chemical products. For example, many of the present inadequacies of Soviet chemicals are caused by insufficient attention to the purity of raw materials or to the uniformity of end products. The use of automation to monitor and control the flow of materials during the chemical process should facilitate the removal of excess impurities and result in an end product with more consistent properties.

The use of alternative or improved raw materials eventually will have a dramatic effect on the quality of Soviet chemical products, particularly in the synthetic materials sectors. An example already noted will be the improvement in Soviet motor vehicle tires by the substitution of nylon and cellulose cord for cotton cord and the use of improved types of synthetic rubber and carbon black.

A further factor in improving the quality of chemical products will be the change in the product mix. This change will be particularly evident in the Soviet fertilizer industry, where the production of complex or concentrated fertilizers should eventually assure agriculture of more effective products. Soviet plans call for a changeover to production of more concentrated and efficient forms of superphosphate and nitrogen fertilizer and to fertilizers containing a variety of nutrients rather than the simple types predominantly produced today.

2. Fulfillment of Production Goals

The Soviet failure to meet chemical investment goals in the first 3 years of the Seven Year Plan, which probably stems from the various problem areas that have emerged with respect to equipment and the mastery of new processes, appears to preclude fulfillment of the goals for 1965 for mineral fertilizers and certain synthetic materials, notably plastics. In addition, the disorganization in planning may well result in disproportionate development of sectors producing basic chemical materials and those producing finished products.

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