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Scientific and Technical Progress in the Chemical Branches of the National Economy

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The strategy designed to accelerate the social and economic development of the country put forward at the April (1985) Plenum of the Central Committee of the CPSU has received wide support throughout the nation and has been approved by the XXVIIth Party Congress.

In the political report of the Central Committee of the CPSU to the XXVIIth Congress of the Communist Party of the Soviet Union, M.S.Gorbachev noted that acceleration is in the first place an increase of the rate of economic growth as a result of a comprehensive intensification of production on the basis of scientific and technical progress, a structural reorganisation of the economy, and effective forms of regulating the organisation and stimulation of labour.

In the principal directives for the economic and social development of the USSR in 1986–1990 and in the period up to 2000, it was stated that it was intended to solve the key political and economic problems—to accelerate comprehensively scientific and technical progress, to raise decisively the role of science and engineering in the qualitative transformation of productive forces in switching the economy onto the track leading to comprehensive intensification and in increasing the efficiency of productive forces of the community, and to direct the scientific and technical development towards the solution of social problems.

In the twelfth five-year plan as a whole for the national economy, it is already essential to achieve two-thirds of the growth in the productivity of socially useful labour by employing the advances in science and engineering and by the year 2000 the productivity of socially useful labour must be raised by a factor of 2.3–2.5. The task of the universal husbanding of resources has been set. Thus the increase in the requirements for fuel, energy, raw materials, and other materials should be satisfied to the extent of 75–80% as a result of economies. The energy consumption involved in the national product should be reduced by a factor not less than 1.4 and the consumption of metals by a factor of almost 2.

The XXVIIth congress of the CPSU placed before Soviet scientists the task of vigorously redirecting science towards the needs of the technical re-equipment of the national economy to bring it into closer contact with production and to employ for these purposes new improved forms of integration and interaction, to accelerate the incorporation of the results of research for practical purposes, and to improve the efficiency of academic and branch institutes.

A major role is assigned to chemical science and industry in the solution of the above problems.

One of the effective means of raising the level of the national income, of satisfying the growing needs of the population, and of accelerating scientific and technical progress in virtually all the spheres of activity of Soviet man is increased application of chemistry in the national economy.

After the May (1958) Plenum of the Central Committee of the CPSU, chemical industry developed at a high rate: the output of the principal forms of chemical production increased by a factor of 6–10 and that of individual products by a factor of 50 and more.

It is also noteworthy that the level of application of chemistry to the national economy of the USSR lags behind the corresponding level in the developed capitalist countries

and the majority of countries which are members of the Council for Mutual Economic Aid.

Whereas at the present time the USSR is ahead of the USA in the volume of steel smelted to the extent of 45%, in the production of cement by 60%, and in the production of saw timber by 10%, the output of the chemical industry in the USSR is of the order of 40% of that in the USA and the output of plastics is only 18% and of chemical fibres 30%. The output of the main types of chemical products, especially synthetic resins and plastics, chemical additives, and products of fine organic synthesis lags by a factor of 1.5–2 behind the needs of the national economy.

One should also bear in mind that the assortment of chemical additives, chemical plant protecting agents, paint and varnish materials, reagents and especially pure substances, special purpose rubbers, and products of organic synthesis is also inferior to that available abroad; it is necessary to improve the quality of the cinematographic and photographic materials, magnetic carriers, constructional polymers and general purpose polymers, dyes, chemical fibres, filaments, mineral fertilisers, etc.

Analysis has shown that the chemical conglomerate exceeds at the present time the average industrial indices, per unit industrial output, by a factor of 1.5–1.6 in terms of the capital invested and by a factor of 3 in terms of the energy consumed. The industrial output per worker is approximately 1.5 times higher than the industrial average.

Thus an increase of the technical level of the chemical industry and improvement of chemical technologies has a major influence on the improvement of the most important technical and economic indices as a whole and wide-scale application of chemical products influences the acceleration of scientific and technical progress in the national economy of the country.

In view of this the Central Committee of the CPSU and the Council of Ministers of the USSR approved in October 1985 a combined programme for the application of chemistry to the national economy of the USSR in the period up to the year 2000. The programme provides for the extensive application of new chemical materials and products, for the successful introduction of the Foodstuffs Programme of the USSR, the Energy programme of the USSR, the Combined Programme for the Development of the Manufacture of Consumer Goods and Services, for the improvement of the living conditions of the Soviet people, and for the strengthening of the economy of our country. Also it determines the fundamental indices and directions of scientific and technical progress in chemical industry.

The chemical branches of the economy should ensure an increase of the output of the chemical industry in 1986–1990 by 130–131% compared with 1985 and in the period 1991–2000 by a factor of 1.8–1.9 compared with 1990, should greatly reduce the specific consumption of the raw material and fuel and energy resources, and should greatly reduce the ecological contamination by chemical industry. The contribution of chemical products to the total industrial output, which was 6.3% in 1985, should increase to 8% in 2000.

The successful solution of the problems formulated requires the maximum effort and a high degree of responsibility, conscientiousness, and capacity for organisation from all scientists in branch institutes, academic establishments, and higher educational establishments and all research chemists, designers, technologists, and planners concerned with the creation of new chemical processes, technological devices, and industries.

The solution of the problems placed before the chemical branches of the economy requires a fundamentally new approach to the system used to incorporate the advances of science into industry, a profound reconstruction of the economic mechanism and the creation of an integral, effective, and flexible system of management which would make it possible to realise fully the possibilities of socialism.

The development of new technologies and the creation of a new generation engineering for the reconstruction and technical re-equipment of the existing and newly created industries are essential.

The network of scientific organisations must continuously improve and its organisation and structure must be built up in such a way that problems of the realisation of the research–planning–construction–mass production cycle are solved comprehensively and faster.

Scientific and technical progress in the leading branches of the national economy is impossible without the application of modern polymeric materials. Scientific research into the creation and application of new generation polymeric materials with a set of specific operational properties and into the development of new composite materials resulting from their modification is therefore being continuously expanded.

In the manufacture of polyethylene, it is suggested in the first place that the output of low-pressure polyethylene be developed since this will ensure the expansion of the assortment of different brands of polyethylene and in particular the production of linear high- and low-density polyethylene. This will create a basis for the creation and introduction of new technological processes designed to obtain polyethylene in suspension using new bifunctional catalysts and in solution in the presence of highly reactive catalysts on carriers and there is a prospect of employing ideal displacement reactors with catalysts having a selectivity approaching that of enzyme systems.

The production of high-pressure polyethylene is based on waste-free technological processes in plants with a potential unit output of 75 thousand tonnes per annum, which can be raised to 85 thousand tonnes per annum by increasing the degree of conversion. In many applications high-pressure polyethylene will be displaced by linear high- or low-density polyethylene. It is therefore likely that in the future the development of the production of high-pressure polyethylene will be on a smaller scale and it is suggested that the number of existing industries be redesigned for the production of pseudolinear polyethylene.

Together with polymers produced on a mass multitonne scale, constructional polymeric materials for engineering and technical purposes [polyamides, polyacetals, polycarbonate, polysulphone, poly(butylene terephthalate), etc.], having a set of effective strength and deformation properties in combination with good antifriction and electrically insulating properties and a reduced combustibility, will be developed extensively. These materials are irreplaceable in certain branches of engineering and industry. Their extensive application will make it possible to increase by a factor not less than 2 the productivity of labour, and to reduce by a factor of 10–20 the consumption of metals, and by a factor of 8–10 the consumption of energy.

The modification of existing polymeric materials is a promising and vigorously developing method of preparation of new polymeric materials with properties specified beforehand. Together with the development of traditional physical modification methods by creating compositions comprising mixtures of polymers with fillers, other polymers, reinforced fibres, and laminate materials, the methods of chemical modification in the stages involving the synthesis and processing of polymers have been used on an increasingly large scale. The fundamentally new technology of polymerisation filling is of special interest. In this technology

the active polymerisation centres are fixed in some way on the surface of the filler particles after which polymerisation is carried out directly on such particles, which makes it possible to coat the latter by polymer shells of different shape and composition, achieving thereby the specified microstructure of the composite material.

Vigorous research is being prosecuted on these lines at the present time in many scientific centres of the USSR. The results of some investigations have been applied on an experimental industrial scale and new materials are being widely introduced under real operating conditions.

Polymerisation-filled polyethylene, which has been called komponor, has been manufactured under experimental industrial conditions. This is a constructional material with a high impact strength, constructional strength, frost resistance, low combustibility, and other valuable properties. The resistance of komponor to wear is greater by a factor of 2 than that of world brands of high-molecular-weight polyethylene. Methods whereby komponor can be made into sheets, articles with a specific profile, and other articles, including those for constructional machine engineering, have been developed.

Scientific research designed to create and introduce new types of chemical fibres with a comprehensive set of properties, superior to those of traditional materials, has been extensively developed and is not likely to lose its contemporary usefulness. These include the most promising carbon fibres and the synthetic SVM† cord, high-strength, high-modulus, incombustible, and thermostable fibres, and electrically insulating, chemisorbing, hollow fibres with selective properties. The development of methods of preparation of high-strength and high-modulus fibres on the basis of fundamentally new procedures for the processing of traditional flexible chain polymers is particularly timely.

Specialists in the chemical industry together with scientists at the Lomonosov Moscow State University and the USSR Academy of Sciences have laid the scientific foundations for and deduced a new novel technological principle for the strengthening of fibres made of flexible-chain polymers, which makes it possible to increase by a factor of 1.5 the strength and by a factor of 1.5–2 the modulus of elasticity of synthetic composite film filaments and monofilaments.

Studies in this field are being continued and we can legitimately expect that the introduction of synthetic filaments manufactured by means of the new technology will yield an appreciable economic effect in the future. Thus the strength of cables made of monofilaments is higher by 10–20% than that of cables made of composite filaments having the same linear density. Tests on trawls made of monofilaments manufactured using the new technology demonstrated that their employment will increase the rate of trawling and result in a 10% fuel economy by reducing the hydrodynamic resistance of the trawl.

The new fibres will make it possible in the future to displace completely natural fibres from engineering and to direct the resources thus freed towards the manufacture of consumer goods.

Progress in modern science and the development of atomic and electronic technology and, during the last decade, information transmission technology using fibre optics and biotechnology impose increasingly severe requirements as regards the quality of specially pure substances and chemical and biochemical reagents for technological, analytical, and research purposes.

Much importance is attributed and will be attributed to the development of the manufacture of complexones—a promising class of compounds with a high sorption capacity. The use of complexone in small amounts makes it possible to solve important problems in the national economy with a large economic effect. Thus complexones prevent scale formation in rotation cycles in the water cooling of power generation equipment in electric power stations, in atomic ice-breakers, and in community heating systems. The use of complexones in the extraction of petroleum will make it possible to prevent almost completely salt deposition in the equipment used. Complexones remove interfering metals from liquid fuel, act as flame extinguishers and modifiers of the rate of combustion of solid fuel, and are used successfully in the electronic industry in the etching and thorough cleaning of surfaces. The expansion of the assortment of complexones and an increase of their industrial output are based on continuous waste-free automated technological processes, where the waste from other chemical industries is frequently used as the raw material.

Scientific research into scintillation, optical, acoustic, and semiconducting crystals for quantum electronics has supplied various branches of the national economy with materials whereby the monitoring of the operating conditions of instruments and devices can be simplified.

The latest non-silver materials have led to the prospect of creating optical discs with a higher recording density, a long storage life, and many other advantages compared with traditional magnetic carriers.

Biochemical preparations are already widely used in the food and medical industry, in agriculture, and other branches of the economy. It is noteworthy that the future development of scientific research and the utilisation of its achievements in molecular biology, genetics, biotechnology, and also bio-organic chemistry depends in many respects on the supply of these preparations.

The need to economise water has led to the expansion of the manufacture of polyelectrolytes, ion-exchange resins, organic amines, silicates, and phosphate compounds for the chemical treatment of water for the purpose of its purification and repeated utilisation.

Measures undertaken to economise on fuel and raw materials have led in recent years to an increased requirement for chemical agents such as corrosion inhibitors, biocides, chelates, antioxidants, special purpose surfactants, food additives, and fuel additives.

Scientific developments in the manufacture of mineral fertilisers have been directed primarily to the expansion of the assortment of advanced varieties. The nitrogen conversion processes in the soil are regulated and a more complete utilisation of nitrogen by plants is achieved by introducing nitrogen fertilisers with nitrification inhibitors. The organisation of the manufacture of a new type of liquid nitrogen fertilisers is proposed. They consist of a 32% solution of carbamide and ammonium nitrate and contain almost no free ammonia, which makes it possible to eliminate almost completely the loss of nitrogen.

The production of liquid fertilisers will reduce the cost of their manufacture by eliminating a number of stages in the technological process and also will result in a significant economy of labour concerned with the storage and movement of the material as a consequence of the complete mechanisation of unloading and loading. The possibility of transporting these fertilisers and their storage in the usual containers all the year round in the majority of climatic zones of the country must be included among their advantages.

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†Possibly 'synthetic high modulus' (SHM) cord (Ed.of Translation).

The assortment of phosphorus fertilisers has been expanding due to the production of new highly concentrated fertilisers: ammonium polyphosphate (58% P_2O_5 and 12% N_2) and calcium polyphosphate (41% P_2O_5).

The difficulties in expanding the manufacture of phosphorus fertilisers are due to the inadequate supply of concentrated raw materials. The output of Kola apatite is being stabilised. The entire increase in the amount of phosphorus-containing raw materials will be achieved by employing the ores from the Karatau basin, which are difficult to enrich, and also by including in the economic turnover new deposits located in sparsely populated regions with severe climatic conditions. The ores from these deposits have a low phosphorus content. For this reason, new forms of fertilisers obtained from low-percentage phosphate ores are being developed and tested under industrial conditions. Superphosphate manufactured by means of a new technological scheme involving economies in the consumption of sulphuric acid has been assessed as highly effective. The output of thermophosphates and fused magnesium phosphates will be expanded.

Potassium chloride occupies a leading place in the assortment of potassium fertilisers. The task of expanding the manufacture of chlorine-free potassium fertilisers and in the first place potassium sulphate has now been formulated. The creation and introduction of continuous processes in the manufacture of chlorine-free forms of potassium fertilisers is planned.

From 1988, potassium fertilisers will be produced solely in the granulated and coarsely crystalline form. It will be suitable for use in dry fertiliser mixtures and their losses during transport and the contamination of the environment by dust fractions will be reduced.

Another problem, on which scientists are working, is closely related to the expansion of the assortment of fertilisers—namely the increase of the average content of nutrient substances in mineral fertilisers. Definite advances have already been achieved in this direction. In the XIth Five Year Plan the average content of nutrient substances in fertilisers rose by almost 4% and now amounts to 41.5%. In the immediate future it will be increased to 43–44%. In assessing the importance of this problem, one should bear in mind that an increase of the average content of nutrient substances in fertilisers under the conditions of their present output will reduce the annual amount transported by 5 million tonnes and result in the saving in agriculture of up to 5 million man hours in connection with the employment of fertilisers.

The scientific and technical progress in various branches of the economy is achieved by improving the technology and by employing plants with a high potential unit output. This is clearly seen in relation to the progress in the manufacture of ammonia. The first imported plant had an output capacity of 3000 tonnes of ammonia per year. Plants with a daily productivity of 1300 tonnes are now working in the industry. Altogether about 40 large-scale plants concerned with the manufacture of ammonia are now functioning, which constitutes more than half of such plants in the world.

The application of the technological process for the manufacture of ammonia in plants with a unit output capacity of 500000 tonnes per year makes it possible to reduce by 20 to 25% the energy consumption and by 30% the consumption of natural gas. The economic effect of production in large-scale plants is greater by 20–30% than in traditional plants.

The organisation of the manufacture of sulphuric acid under pressure in plants with a unit output capacity of 700000 tonnes per year will make it possible to reduce, compared with traditional technologies, the unit capital outlay by 20–25% and to increase the labour productivity by a factor of 1.5–2, while the amount of harmful waste discarded into the atmosphere will be reduced by a factor greater than 5. The consumption of metals by the plant will be at the same time lowered by 2200 tonnes.

In the XIIth Five Year Plan, it was proposed to develop a plasma-chemical process for the manufacture of nitric acid directly from air. The new method will make it possible to increase greatly the production of nitrogen fertilisers at a minimum cost.

It is planned to achieve scientific and technical progress in the potassium industry by introducing new devices for the excavation of potassium strata which will increase by a factor of 1.5 the labour productivity and will greatly reduce the amount of waste from potassium undertakings.

A fundamentally new process for the conversion of potassium ores is electrostatic separation whereby a 95% concentrate can be obtained with a significant economy in the energy expenditure (by 20–25%). The new technology enables one to eliminate liquid waste from the manufacturing process and to abolish sludge storage containers. The process is susceptible to automation, which will reduce the amount of labour required.

The structural alteration and expansion of the raw materials base for the manufacture of phosphorus fertilisers will be ensured by enriching poor phosphate ores with the aid of flotation, thermal, chemical, and thermochemical processes. In the relevant branch of the economy much attention is also devoted to the introduction into industry of new methods for the underground and open-cast extraction of phosphate ores, their hydroextraction, and their underground leaching.

Chemical plant protecting agents are important for agriculture. In the relevant fields plans have been laid to expand the range of prepared forms of pesticides to 90–95 items in 1990. Particular attention is devoted to the development and production of preparations used in intensive technologies for the growing of agricultural produce.

The improvement of the structure of pesticides and of their quality will be achieved on the basis of the leading manufacturing processes for preparations with a high selectivity of action, which decompose rapidly in the environment and which make it possible to reduce the norm for their consumption per hectare by a factor of 100 and more compared with those employed at the present time.

One of the difficulties in expanding the assortment of chemical plant protecting agents is the fact that the equipment used to manufacture individual preparations is frequently needed for a single item only and machine constructors are not objectively interested in its production. For this reason, one of the directions to be followed in the development of science and engineering in this field involves the creation of flexible technological systems, the so-called modular plants, which make it possible to manufacture different products using a common raw material or intermediates.

In industrial organic synthesis, new technological processes have been developed and introduced on the basis of modern apparatus systems ensuring the maximum output of the required products and the complex utilisation of the raw material and intermediates.

The plan for the period up to 2000 provides for a radical re-equipment of industry, the development and introduction of highly effective technological plants with a high unit output capacity, the intensification of the existing industries on the basis of new catalysts and catalytic systems, the application of fundamentally new less energy-consuming technologies, and the search for less expensive types of raw material.

In particular, it is intended to create plants for the pyrolysis of petroleum fractions by means of a waste-free technology using heterogeneous catalysts, to continue work on the creation of new types of biodegradable surfactants in order to expand their assortment and applications, to organise the manufacture of n-propyl alcohol and propionic acid in order to obtain chemical plant protecting agents and to employ them as preservatives for grain feed and green forage, to develop and create new industries manufacturing butyraldehydes in the presence of a rhodium catalyst, α-olefins, ethyl methyl ketone, isobutyl methyl ketone, isobutylmethylmethanol, etc., to complete the development of a less energy consuming process for the synthesis of butadiene by the single-stage oxidative dehydrogenation of butane in fluidised bed reactors, and the single-stage synthesis of isoprene from isobutene and formaldehyde with a unit output capacity of 120000 tonnes per year, which is characterised by an amount of waste water smaller by a factor of 6, energy requirements smaller by a factor of 2.6, and the consumption of formaldehyde per tonne of isoprene smaller by 25%.

The introduction of the above and other processes will permit the maximum satisfaction of the needs of the national economy for the products of organic synthesis, to reduce the consumption of raw materials and energy resources, and to achieve a saving amounting to more than 250 million roubles per year.

The problem of supplying the tyre and rubber industries with general purpose raw rubbers has now been virtually solved and the proportion of the required imported natural rubber is minimal. For this reason, in the XIIth and subsequent Five Year Plans, development of special purpose raw rubbers has been emphasised, namely the development of modified raw rubbers and both low-molecular-weight and other thermoelastoplastics, which sharply improve the quality of rubber mixtures and reduce the labour involved in their processing.

It is planned to organise the large-scale manufacture of ethylene-propene rubbers at the Nizhnekamskneftekhim PO and acrylate rubbers for the manufacture of technical rubber articles with high heat and oil resistances, to introduce thermoelastoplastics which it will be possible to process by casting under pressure and by extrusion, to eliminate the vulcanisation stage which will permit an appreciable increase in labour productivity, to improve the quality of the product, to reduce the norm for the consumption of the raw material and other materials, and to reduce the amount of imported materials. It is intended to introduce butadiene-styrene rubbers manufactured by solution polymerisation (DSSK). Their application in the tyre industry will increase the useful life of tyres by 5%, while in the light industry their use will increase the wear and frost resistance of shoe sole rubbers and in the manufacture of technical rubber articles it will lead to an increase of the heat resistance and useful life of conveyor belts by a factor of 2–2.5.

The tyre industry has at the present time an output capacity of 74 million tyres. For this reason the main task is to increase the quality of the tyres by increasing the output of radial metal-cord tyres and by employing new types of chemical additives which sharply improve the quality of rubber. The increase in the volume of production of radial tyres will be achieved by the reconstruction and expansion of the existing undertakings and by eliminating cross-ply tyres from industrial production.

At the same time it is planned to develop and introduce advanced equipment for the assembly and vulcanisation of tyres. Thus it is intended to improve the manufacture of light tyres by creating preparation-assembly aggregates of automated machines using manipulators. A technology and equipment have been devised for the vulcanisation of tyres using ultrahigh frequency currents.

The output and assortment of retreadable tyres have increased, including an increase in the output of retreaded radial tyres.

In the industry concerned with technical rubber articles provision is being made for the introduction of processes for the preparation of articles and materials from liquid hydrocarbon rubbers, which will increase the labour productivity by a factor of 2–3 and improve the quality of the articles. Work will be continued on the creation of technical rubber articles from powdered rubber mixtures. The application of this technology will reduce by 30% the consumption of the rubber mixture, by a factor of 1.5 the labour expended at the moulding and vulcanisation stage, and by a factor of 2 the amount of waste.

In the manufacture of flat wedge-shaped and ventilated belts, an improvement in quality together with an increase of useful life by a factor of 1.8–2 by improving the construction and technology of their manufacture and by using new materials are planned. Thus provision is made for the organisation of the manufacture of flat belts with polyamide cores and driving belts with a low transmission capacity from thermoelastoplastics.

The June (1985) conference at the Central Committee of the CPSU on the questions of acceleration of scientific and technical progress was devoted to a profound analysis of the existing situation as regards problems involved in the introduction of scientific developments into industry and the search for reserves which could alter radically the existing situation and increase the technical level of the industries and the quality of the products.

Problems concerning the improvement of the network of scientific organisations and an increase of their effectiveness were carefully examined at all levels of management of different branches of industry.

Comprehensive study led to the proposal for a series of organisational and technical measures and proposals have been developed for a radical improvement of the planning system and the stimulation of work on the creation of a new technology.

The most effective form of the association between science and industry under modern conditions is the Scientific-Industrial Association SIA (NPO in Russian).

In his report at the XXVIIth Congress of the CPSU "The Fundamental Directions of the Economic and Social Development of the USSR in 1986–1990 and in the Period up to 2000", N.I.Ryzhkov said: "It is necessary to work faster on the organisation of scientific-industrial associations. They have been called upon to be at the cutting edge of scientific and industrial progress. Solely by carrying out simultaneously different stages of the necessary work, by liquidating superfluous units, and by centralising management, the duration of the development cycle from research to incorporation into industry has been reduced in leading SIA on average by a factor of 1.3–1.6. The SIA have the necessary component elements for the application of their achievements in industry: scientific establishments, an experimental base, a planning section, and initiating and adjustment subsections—they act directly in the undertaking having been given by it the task of organising the future industrial plant; at the end of its construction they hand over to the undertaking the plant as a growing concern".

This form of organisation enhances the aspect of planning concerned with its programme and aim and shortens the time taken to execute the programmes.

In 1986–1987 the work on the creation of new SIA will be continued and after its completion more than 70% of the expenditure on science and on the employment of scientific workers will be concentrated in them.

In order to solve the strategic problem of accelerating the social and economic development of the country formulated by the April (1985) Plenum of the Central Committee of the CPSU and the conference of the Central Committee of the CPSU on the problems of the acceleration of scientific and technical progress, the concentration of forces and means on the priority fields of science and engineering in order to gain world leadership in such fields in the shortest possible time has acquired the greatest importance.

The decision of the Central Committee of the CPSU and the Council of Ministers of the USSR to create interbranch scientific-technical complexes and to undertake measures to ensure their proper activity has been approved. It is proposed to create in the principal fields of scientific and technical progress interbranch scientific-technical complexes designed to perform the entire cycle of work on the creation and introduction into industry of highly effective types of engineering, technology, and new generation materials and at the same time to reduce severalfold the duration of the work cycle from scientific research to practical introduction of its results into the national economy.

Scientific research establishments, constructional and technological organisations, and the associations and undertakings of the Ministries and Departments of the USSR and the Union Republics which possess the required scientific and technical potential in the relevant fields and which assist in the comprehensive solution of problems are involved in the work of the interbranch scientific-technical complexes.

The interbranch scientific-technical complexes are the leading organisations in the country concerned with the performance of tasks, given to them, in the field of science and engineering and the financial, labour, and material-technical resources, specified capital investments, and contract work, which are necessary for the realisation of plans, will be provided for in the first instance in the plans of the Ministries and Departments within the system of which these complexes are included.

Two interbranch scientific-technical complexes ISTC (MNTK in Russian) have been created for the priority fields of the chemical branches of the national economy: the "Catalyst" ISTC, the "Membranes" ISTC, and, in the field of biotechnology, the "Biogen" ISTC have been set up.

Catalytic processes, which significantly expand the possibilities and radically alter the structure of the consumption of raw materials and intermediate products, have acquired special importance in our time. Nowadays 80–85% of technological processes in the chemical industry are performed with the aid of catalysts and the total output obtained in catalytic processes has been estimated as approximately 1/5 of the entire world industrial output.

The development of catalysts is a key problem in the realisation of the fundamental pathways leading to technical progress in chemical industry, ensuring a transition from extensive to intensive forms of industrial production. The creation and utilisation of more active catalysts leads as a rule to the possibility of increasing the productivity of plants as a whole without their reconstruction. Thus, catalysts so active that they can yield up to 1.5–2 tonnes of the polymer per gram of the catalyst have been created for polymerisation processes leading to polyethylene. Such a small amount of catalyst can be left in the bulk of the polymer without impairing its quality and hence one can exclude from the technological scheme the washing stages which consume up to 40% of the entire capital expenditure on the industrial process. The application of highly active catalysts will make it possible to improve the technological parameters of many processes. For example, it will be possible to reduce the pressure from 200 to 30–50 atm in the manufacture of high-pressure polyethylene and from 300 to 100 atm in the manufacture of methanol. The period in which industrial catalysts are renewed is 7–10 years at the present time and it is planned to renew the most important catalysts each 4–5 years in the future.

Apart from the radical improvements to industrial technological processes, the development of the science of catalysis makes it possible to predict the creation in the immediate future and even more so after 10–15 years of tens of fundamentally new catalytic processes which will significantly expand the possibilities of chemistry and alter radically the structure of the consumption of raw materials and intermediate products. For example, the processes involving the formation of motor fuels and many chemical intermediate products from a mixture of carbon monoxide and hydrogen obtained by the conversion of natural gas and the gasification of coal are very close to practical realisation. This will mean a transition in the future from expensive petroleum to a new raw material in a major branch of the chemical industry, which will involve the manufacture of high-octane petrol, aromatic hydrocarbons, and polyolefins. Methanol is an important chemical raw material. Acetic acid is already being synthesised from it and a process involving the synthesis of formic acid, an important feed preservative, is undergoing experimental tests. One may expect the creation of new processes leading to the synthesis of acetaldehyde, ethylene glycol, ethanol, glycerol, carboxylic acid esters, and many other important chemical products. Processes involving the catalytic stereospecific synthesis of optically active aminoacids—feed additives and pharmaceutical preparations—and also bio-organic processes carried out with the aid of immobilised enzymes, for example, the preparation of sugars from waste in the processing of wood, etc., are close to being realised. Catalysts accelerating the conversion of coal into a synthetic liquid fuel, which constitutes an important contribution to the solution of the fuel and energy problems, are being created. For each chemical process, the trend towards a rational utilisation of energy is extremely specific. Thus, whereas the activation energies for thermal processes are 120–160 and sometimes up to 200 kJ mol^{-1}, in catalytic processes the energy falls to 20–30 and sometimes to 7–8 kJ $mole^{-1}$, while in processes involving bio-organic enzyme catalysts it falls even to 1 kJ mol^{-1} and below. Thus the development of an active catalytic system for the synthesis of aliphatic amines made it possible to achieve a saving in the energy resources by 15%, while the intensification of the synthesis of polyethylenepolyamines in the presence of new catalytic systems resulted in a 60% saving.

The possibilities inherent in the introduction of membranes and the membrane technology into different branches of the national economy are very great. For example, the introduction of the membrane technology into thermal power engineering reduces the amount of waste water in the thermal power plant by a factor of 4 and reduces the consumption of alkali and acid by 50%.

The introduction of the resources-conserving membrane technology into the food industry may also serve as an important component for the successful realisation of the Food Programme. The membrane purification, clarification, and stabilisation methods in the production of sugar, juices, and alcohol-free drinks and also in the extraction of food dyes, plant proteins, and other useful substances from the waste generated in the processing of food products make it

possible to reduce greatly the energy expenditure in the preparation of food products, to improve their quality, to increase the storage time and food value of the products by means of cold sterilisation, to extract additional amounts of food raw materials which were hitherto irretrievably lost, and to reduce the contamination of the environment by the waste from food industries. The application of membrane processes in the combined processing of milk and secondary milk products will greatly reduce the energy consumption in the relevant industries, will increase the output of the finished products, will increase the assortment and quality of such products, and will greatly reduce the cost of transport in the delivery of the milk raw material. The introduction of methods for the storage of fruit, vegetables, and grain in a modified gaseous medium using membranes increases the storage time and makes it possible to supply consumers with fresh produce all the year round with a significant reduction of losses during the storage process.

The role of membranes and membrane technology in the protection of the environment from contamination is incontrovertible. Membrane devices and apparatus are used for the analytical monitoring of the environment (sewage and gaseous waste). Furthermore, the use of membrane technology leads to the possibility of creating effective desalination processes for salt and brackish waters and also the creation of closed water cycles in industrial manufacturing processes.

One of the most important ways of increasing the technical level of the chemical sub-branches in industry and of carrying out the tasks involving their intensive development consists in the comprehensive expansion of the cooperation with the Academy of Sciences of the USSR, the Academicians of the Academy of Sciences of the Union Republics, and higher educational establishments in the USSR.

It is generally known that, whatever the advances in the relevant fields of science, it is impossible to raise the technical and economic level in industry to leading positions without an adequate and profound fundamental effort and without cooperation with academic organisations and higher educational establishments. For this reason, starting from the Tenth Five Year Plan, nine regional centres, covering the entire Soviet Union and coordinating joint research and developments, have been active in chemical industry. This is consistent with the task formulated in the report by M.S.Gorbachev at the June conference in the Central Committee of the CPSU, who noted that: "... we should look upon scientific tasks through the prism of the requirements of the present time—requirements for the decisive redirection of science towards the needs of the consumer industry and of the industry towards science. All the units of the chain connecting science, engineering, and industry must be analysed and strengthened from these standpoints".

During the Eleventh Five Year Plan 80 higher education establishments and 95 academic institutes participated in the joint developments concerned with the coordination of plans with branch institutes. The effectiveness of such cooperation is evident. Thus the theoretical principles and technology of the industrial manufacture of film filaments for hay binding twine were developed and the production was organised jointly with the Lomonosov Moscow State University. This made it possible to satisfy fully the needs of agriculture and to achieve a saving amounting to 73 million roubles. A theoretical and practical approach to the welding of polymeric materials, especially polymer tubes, was developed for the first time in world practice jointly with the Paton Institute of Electric Welding of the Ukrainian Academy of Sciences. This problem has now been solved. The economy now receives plants for the welding of polyethylene tubes having diameters ranging from 11 to 1200 mm.

Many such examples can be quoted.

At the same time the existing level of cooperation does not satisfy all the increasing modern needs by academic institutes and higher education establishments. The absence of an adequate experimental base retards the application of the results of completed research in industry. Also the problem of the economic stimulation of the participation of scientists at academic institutes and higher education establishments in the incorporation of scientific developments in industry has not been solved.

In laying the plans for the XIIth Five Year Plan, a fundamentally important resolution was adopted, namely the resolution to achieve a transition to improved forms of planning of joint developments—a programme for the interdepartmental scientific and technical cooperation of the Ministry of Chemical Industry, the Academy of Sciences of the USSR, the Academies of Sciences of the Union Republics and the higher education establishments controlled by ministries.

The principal methods of cooperation for 1986–1990 and for the period up to the year 2000 have been approved. The most important of these is the creation of a new generation of technological processes based on the fundamental work already completed. A comprehensive Programme for scientific and technical progress in the member countries of the Council for Mutual Economic Aid CMEA (Russian abbreviation SEV) up to the year 2000 was adopted at the 41st session of the CMEA. The meeting of the General Secretary of the Central Committee of the CPSU Comrade M.S.Gorbachev with the heads of delegations of the socialist countries and the Secretaries of the Central Committees of the fraternal parties, participating in the session of the CMEA, was especially important. The fundamental approach to the radical questions of the acceleration of scientific and technical progress and internal economic and international politics described at the meeting received full support and understanding.

The consistent realisation of the Comprehensive Programme will accelerate the social and economic development of our country and fraternal states on the basis of the latest scientific and technical advances, will ensure a radical improvement in labour productivity, and will strengthen technical and economic independence. A more complete utilisation of the possibilities of the economic interaction with fraternal socialist countries in ways including the application of progressive forms—wide-scale scientific and technical and industrial cooperation, direct links, and the creation of joint associations and undertakings—is linked to the Programme's realisation.

Major tasks within the framework of the Comprehensive Programme are also to be performed by chemists. Thus in the field of "Biotechnology" the USSR, Czechoslovakia, Hungary, and the German Democratic Republic will create a joint assortment of hundreds of named reagents which will improve the scientific level and shorten the time taken for research in the field of genetic engineering, biology, and biochemistry. New generations of medicinal and enzyme preparations will be introduced into the health service.

New biological plant-protecting agents and veterinary preparations will be introduced for the needs of plant cultivation and animal husbandry.

An important role is attributed to an increase of output in the manufacture of protein feeds.

In the field "Electronisation of the National Economy", technologies have been developed for the manufacture of tens of designated new specially pure substances for microelectronics, including the equipment for their industrial manufacture, analytical monitoring methods, and special

packing. This will improve the speed and reliability of the operation of electronic circuits in electronic computers and will increase the sensitivity of various instruments.

Technological plants based on the block-modular principle will be developed and created jointly with Czechoslovakia, which will permit the manufacture of a large assortment of low-tonnage chemical products with the aid of rapidly readjustable schemes.

Tasks directed to the creation of new polymeric materials for radioelectronics, electrical engineering, machine construction and other leading fields are planned within the framework of the priority field "New Materials and the Technology of Their Manufacture and Treatment". The application of these materials in place of traditional ones will ensure technical progress in the branches of economy consuming them and will increase the reliability and useful life of the products in the course of their employment and will reduce their cost.

Provision is also made for the development and introduction of new and improved technological processes for the manufacture of polymeric materials and articles made from them with a wide-scale employment of computer and micro-processor technology and highly selective catalytic systems stimulating energetic effects.

The task of accelerating scientific and technical progress imposes new, more stringent, requirements on cadres and the style and method of their work. There is a need to achieve throughout a freedom from conservatism, paper work, and a formal attitude to work. The complex and large-scale tasks formulated by the Party require a creative initiative and diligent labour by each worker in chemical industry. The successful performance of the planned tasks and the making of scientific and technical progress in the major fields of development of the given branch of the national economy are the tasks faced nowadays by workers in Soviet industry.