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9 January 1980

USSR Report

CHEMISTRY

(FOUO 1/80)

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USSR REPORT

CHEMISTRY

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ISOLATION AND PROPERTIES OF HIGHLY PURIFIED TYPE E BOTULINUS TOXIN

BIOKHIMIYA in Russian No 8, 1979 pp 1392-1400

[Article by G. A. Levdikova, L. V. Klimacheva, M. V. Ispolatovskaya, T. I. Bulatova and L. I. Anisimova, Institute of Epidemiology and Microbiology imeni N. F. Gamaleya, USSR Academy of Medical Sciences, Moscow, submitted 13 Nov 78]

[Text] A new method is described for isolation of highly purified toxin from type E Cl. botulinum, from centrifugates of culture fuid of strain 188. This method permits isolation of toxin both in the form of precursor and in activated from with a 10-15% yield. The method involves separation using ammonia sulfate, ultrafiltration and successive chromatography on colunns with DEAE cellulose, sephadex G-200 and DEAE sephadex A-50. Homogenity of the obtained products is confirmed by electrophoresis in polyacrylamide gel and immunoprecipitation in agar with antitoxic horse serum. The potential specific toxicity of the isolated product constitutes $1\text{-}1.2 \cdot 10^7$ MLD per mg protein. Determination was made of the molecular weight of toxin, the level of which is in the range of 160,000, and coefficient of molar extinction at 278 nm. The isoelectric point is at pH 6.0. The highly purified type E. Cl. botulinum toxin is stable when stored.

Botulinus toxins are proteins with very high biological activity, which are the cause of severe intoxication often leading to death of man and animals. We know of seven types of pathogens that produce toxins with strict specificity.

Unlike other types of toxin, type E is synthesized in the form of precursor with potential toxicity that is manifested after incubation with trypsin. The inactivated precursor has the same molecular weight as activated toxin [1, 2].

At the present time, we know of two reports describing methods of isolating toxin from Cl. botulinum type E in a highly purified state. Kitamura et al. [3] were the first to publish a method for isolation and purification of protoxin from type E Cl. botulinum cells. It is virtually impossible to extract information required to reproduce the purification conditions from a more recent work published in the form of a brief abstract [4].

This investigation pursued the goal of obtaining homogeneous botulinus toxin type E from the culture fluid of strain 188 isolated in our country and cultured on Soviet produced nutrient media.

Methods

Recovery of base material: In this work we used strain 188 of type E Cl. botulinum. A centrifugate of a 6-day culture incubated in cellophane bags served as base material. The medium contained the following components: 3.5% acid casein hydrolysate (dry, moderate degree of degradation), 0.05% dry bran, 2% vitamin B (complex) and 0.1% sodium thioglycolate.

Ultrafiltration was performed in a thin-channel TCF 10 A apparatus of the Amicon Company (United States) using zn XM-100 filter at 18°. Use of this phase pursued two objectives: concentration of the toxin solution and dialysis thereof for subsequent chromatography on DEAE-cellulose. We concentrated 500 mℓ product obtained after precipitation of the centrifugate with ammonia sulfate to 150-180 mℓ and "dialyzed" it by flushing 0.05 M acetate buffer, pH 6.0, through the cell in a 5-fold volume (in relation to initial one).

Chromatography on DEAE cellulose was performed on a 2.5×30 cm column at room temperature. DE-32 cellulose of the Whatman Firm (England) equilibrated with 0.05 M acetate buffer, pH 6.0, was used as an ion exchanger. The same buffer was used for eluation.

Gel filtration on sephadex G-200 for purification was performed on double columns, each 2.5×90 cm in size, of the Whatman Firm in 0.05 M acetate buffer, pH 6.0. The overall length traveled by protein constituted 180 cm.

The molecular weight of purified toxin was deterined by gel filtration on sephadex G-200 in a 1.5×80 cm column, in 0.05 M phosphate or 0.05 M acetate buffer, pH 8.0 and 6.0, respectively, with or without 0.2 M NaCl. The volume of eluated fractions constituted 3.5 mℓ. Human gamma globulin, bovine serum albumin and egg albumin were used as markers.

Chromatography on DEAE-sephadex: A 1.5×10 cm column was used for chromatography on DEAE-sephadex A-50. Tests were conducted using 0.05 M sodium-phosphate buffer, pH 8.0, at room temperature. The diluted protein solutions were concentrated by means of precipitation with ammonia sulfate prior to application to columns with sephadex G-200 and DEAE-sephadex A-50.

Protoxin was activated by incubating it with 0.1% trypsin solution, pH 6.0, at 37° for 1 h. To stop the action of trypsin, the incubation mixture was qui cooled in an ice bath, and toxicity of the product was determined immediately.

Toxicity was determined on white mice weighing 14-16 g. Titrated toxin was administered intraperitoneally. Toxicity was expressed in MLD/mℓ (MLD is minimum lethal dose).

Protein content was assayed according to Lowry.

Immunoprecipitation was performed in 1% aqueous agar by the Ouchterlony method of double diffusion with antitoxic horse serum.

Electrophoresis in polyacrylamide gel (PAAG) was conducted at pH 8.3 in tris-glycerin buffer with concentrating gel. For determination of molecular weight of the toxin by the method of electrophoresis in PAAG, tests were performed under previously described conditions [5], using equine gamma globulin, bovine serum albumin, egg albumin and chymotrypsinogen as markers.

Ultracentrifugation was performed using a Beckman L5-50 (United States) preparative ultracentrifuge in a saccharose density gradient of 5-20% (260,000 G, 20°, 18-20 h). We used an SW-40 Ti rotor bucket. Catalase (11 S), gamma globulin (7 S) and bovine serum albumin (4.4 S) were used as markers. After centrifugation, the contents of the tubes were separated into 30 fractions of 7 drops each. To each fraction we added 2.5 mℓ buffer (phosphate or acetate) and determined absorption at 230 nm wavelength using an SF-16 spectrophotometer. The distribution of toxicity was tested by titration on mice. Experiments were conducted at pH 8.0 in 0.05 M phosphate buffer and pH 6.0 in 0.05 M acetate buffer. The sedimentation coefficients were calculated using a previously proposed formula [6].

Isoelectric focusing was performed in an 8101 instrument of the LKB Firm (Sweden) with working column volume of 110 mℓ. In the tests we used "amfolins" in the pH range of 5-8 and 3.5-10 with a concentration of 2%. The tests lasted 42-43 h.

Results

After separation of microbial cells, the culture fluid was precipitated with ammonia sulfate at 50% saturation. The sediment was dissolved in 0.05 M acetate buffer, pH 6.0 (1/6-1/8 of initial volume) and submitted to ultrafiltration through an XM-100 filter for concentration and dialysis. This phase also made it possible to partially remove pigment and low molecular impurities. As compared to the preceding stage, specific toxicity increased by 7-10 times (Table 1), but the product contained a significant amount of nucleic substances, as indicated by the low A_{280}/A_{260} coefficient levels (0.6-0.7). In order to separate the nucleic substances, the concentrated solution of toxin was passed through a column with DEAE-cellulose equilibrated with 0.05 M acetate buffer, pH 6.0. Under these conditions, the toxin was not sorbed and came out with the front of the eluent. After such treatment the A_{280}/A_{260} coefficient rose to 1.7-1.8.

The solution was concentrated by means of precipitation with ammonia sulfate and passed through the dual columns with sephadex G-200 in 0.05 M acetate buffer, pH 6.0. From the elution profile of gel filtration illustrated in Figure 1 we see that the toxin comes out as part of the first protein peak. The results of disk electrophoresis indicated that this peak contains at least two protein components with different charges (Figure 2, *1*), which we designated by the letters A and Б. The slower one (A) is toxic and the other (Б) is inert. Immunodiffusion with equine antiserum revealed that the product obtained at this stage yielded two precipitation bands (Figure 3, II).

Table 1. Purification of Cl. botulinum type E toxin

Purification stages	Volume mℓ	Overall toxicity MLD/10^9	Specific toxicity MLD/10^5	Toxicity yield, percent of: preced. stage	Toxicity yield, percent of: initial stage
Culture fluid centrifugate	7430	2.0	0.2	--	--
Separation with $(NH_4)_2SO_4$, 50% saturation	1000	2.0	1.5	100	100
Concentration & dialysis with XM-100	347	1.3	4.0	65	65
Chromatography on DE-cellulose	327	1.3	12.0	100	65
Concentration with $(NH_4)_2SO_4$	32	1.0	10.0	77	50
Gel filtration through sephadex G-200	106	1.0	40.0	100	50
Concentration with $(NH_4)_2SO_4$	11	0.36	40.0	36	18
Chromatography on DEAE-sephadex A-50	19	0.29	100.0	80	14.5

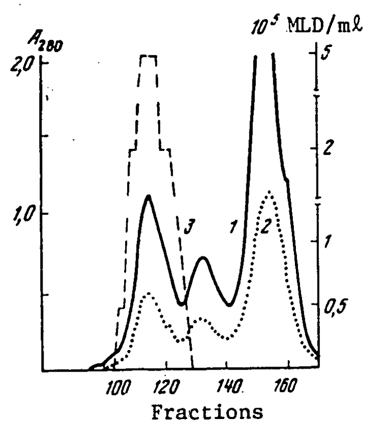

Figure 1.
Elution profile of gel filtration of type E inactivated toxin on sephadex G-200. Conditions described in text.

1) A_{280}
2) A_{260}
3) toxicity

At the last stage of purification the product was submitted to chromatography on DEAE-sephadex A-50 in 0.05 M sodium-phosphate buffer, pH 8.0. In this procedure, the protein fraction containing toxin came out with the front of eluent buffer, while the nontoxic one was adsorbed on the column.

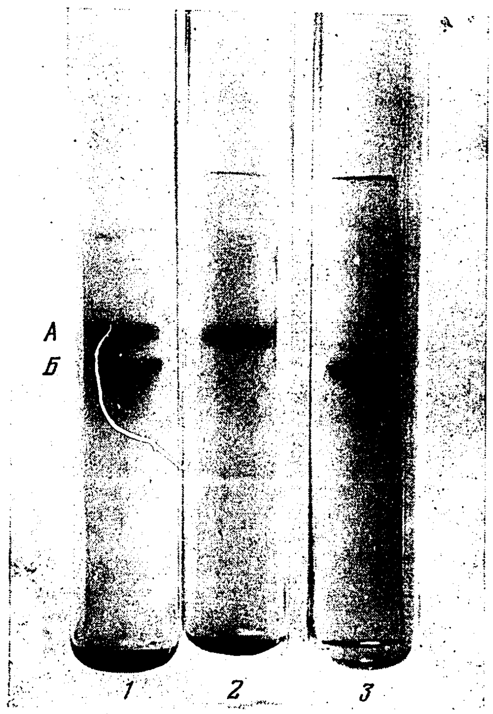

Figure 2. Electrophoresis in polyacrylamide gel, pH 8.3

1) toxin preparation after chromatography on columns with sephadex G-200, band A corresponds to toxic component and Б to inert protein
2) toxin preparation after chromatography on DEAE-sephadex A-50 (A)
3) inert protein (Б)

The chosen conditions made it possible to recover toxin in the form of precursor. When necessary to obtain a preparation in the activated form it was treated with trypsin just prior to gel filtration through sephadex G-200. All of the characteristics of the obtained product are referable to the activated form of toxin thereafter.

The toxin recovered in accordance with the above-described method yielded one band in electrophoresis in PAAG (Figure 2, 2) and one precipitation line in agar with immune antiserum (Figure 3, I).

The highly purified toxin preparation had a specific toxicity of the order of $1\text{-}1.2 \cdot 10^7$ MLD/mg protein and $7 \cdot 10^6$ MLD/unit A_{278}. The molecular weight of toxin, determined by the method of electrophoresis in PAAG with DS-Na constitutes 160,000. However, lower values for molecular weight, from 120,000 to 80,000, were obtained by the method of gel filtration on a column with sephadex G-200, and they depended on the ionic strength of the eluent buffer (Figure 4). The coefficient of molar extinction at 278 nm, calculated for a mol. wt. of 160,000, is 216,000 $M^{-1} \cdot cm^{-1}$.

The highly purified toxin retains activity in solution at pH 8.0 for 1-1.5 months at 5°. When stored in a frozen state at -20°, toxicity remained unchanged for 4-6 months.

Homogeneous protoxin recovered at the final stage of purification becomes quite labile in relation to trypsin. While incubation of unpurified protoxin preparations with trypsin solution (0.1% end concentration) for 1 h usually led to 10-20-fold increase in toxicity (Figure 6), the toxicity of highly purified precursor not only failed to increase under such conditions, it even decreased to below the initial level in some tests. Maximum activation of the highly purified preparation was observed after 5-10 min (Figure 6). In some tests, we could not augment activity of the highly purified product by trypsin treatment.

Similar findings are referable only to the one-component preparation. When an equal concentration of inactivated protein B was added to the latter, activation occurred under the usual standard conditions.

Thus, the presence of inert protein B enhanced stability of the highly purified protoxin against the action of trypsin. Table 2 lists data referable to two such tests.

Table 2. Influence of inert component B on activation of highly purified precursor of Cl. botulinum type E toxin

Experiment No	Incubation medium with			Activity, MLD/mℓ
	protoxin	trypsin	inert protein B	
1	+	+	+	$2 \cdot 10^6$
	+	+	–	$2 \cdot 10^5$
	+	–	–	$2 \cdot 10^5$
2	+	+	+	$4 \cdot 10^5$
	+	+	–	$3 \cdot 10^4$
	+	–	–	$1 \cdot 10^5$

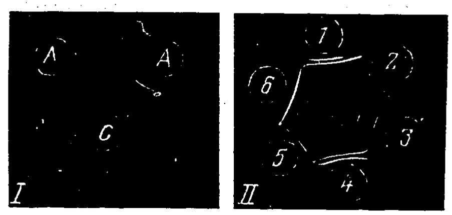

Figure 3. Precipitation of toxic protein A (I) and precipitation of three preparations (II) with immune equine antiserum

I: C) antiserum
II: 1 and 4) product before chromatography on DEAE-sephadex A-50
2 and 5) toxic protein (A)
3 and 6) inert protein (B) adsorbed on DEAE-sephadex A-50; antiserum in the middle

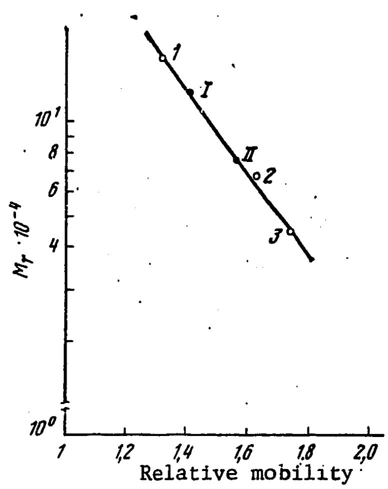

Figure 4.
Calibration curve for determination of molecular weight of highly purified type E toxin by gel filtration through sephadex G-200; 0.05 M acetate buffer, pH 6.0; 1.5×80 cm column

I) relative mobility of toxin in the presence of 0.2 M NaCl
II) without NaCl
1) γ-globulin
2) serum albumin
3) egg albumin

In the studies of Japanese authors [2, 7], it was demonstrated that type E botulinus toxin exists within the microbial cell in the from of a so-called progenitor, which is a complex of two proteins: Eα--toxin proper and Eβ--inert protein. This complex has a sedimentation coefficient of 12S, and it is stable only with an acid pH range. Under mildly alkaline conditions, it is dissociated into Eα and Eβ components, each of which has a sedimentation coefficient of 7S.

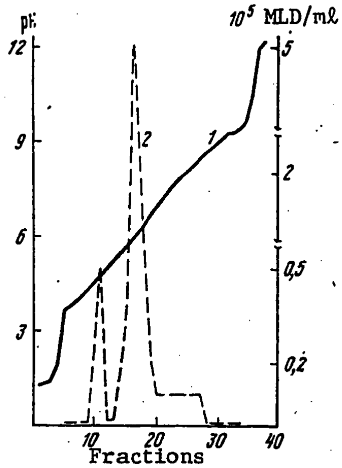

Figure 5.
Isoelectrofocusing of highly purified type E toxin
1) pH 2) toxicity

We assumed that the inactive protein fraction separated from toxin during chromatography on DEAE-sephadex A-50 at pH 8.0 corresponds to the Eβ component, and we conducted several experiments in a preparative ultracentrifuge to check this hypothesis. Tests were made in two different buffer systems at pH 6.0 and 8.0 of the following preparations: two-component protein recovered after gel filtration through sephadex G-200, homogeneous toxin A, inert protein B and a mixture of proteins A and B in equal concentrations. As can be seen in Figure 7, homogeneous toxin A demonstrates sedimentation at pH 6.0 and pH 8.0 like γ-globulin with a sedimentation coefficient of 7.1-7.4S. Protein B presented analogous sedimentation (the data are not illustrated in this figure).

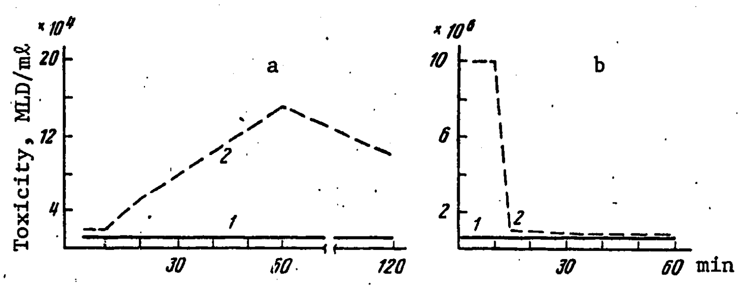

Figure 6. Increase in toxicity of centrifugate of culture fluid of type E Cl. botulinum (a) and highly purified type E (b) as a function of incubation time with trypsin

1) before activation 2) after activation

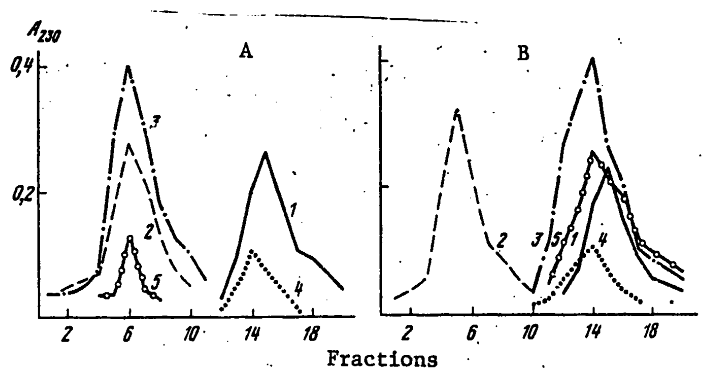

Figure 7. Ultracentrifugation of highly purified type E toxin at pH 6.0 (A) and pH 8.0 (B)

1) γ-globulin
2) catalase
3) two-component protein
4) homogeneous toxin
5) mixture of proteins A and B

When the two-component product recovered at the next to last stage of purification, which yields two bands upon electrophoresis in PAAG at pH 8.3, was submitted to ultracentrifugation we observed a different finding: When centrifugation was performed at pH 6.0 (Figure 7A), toxicity was demonstrable in the only protein peak presenting a sedimentation coefficient of 11-12S. At pH 8.0 (Figure 7B), the toxicity concentrated in one peak was again found in fractions with the same sedimentation rate as γ-globulin.

We then mixed the highly purified toxin A and inert protein B obtained at the last stage, and the preparation was centrifuged at pH 6.0 and 8.0 (Figure 7). We obtained the same results as in analysis of the unadulterated two-component protein. Thus, these findings warrant the conclusion that inert protein B corresponds to component Eβ in the terminology of Japanese authors [7], while the two-component system in the preparation obtained after gel filtration through sephadex G-200 apparently is the so-called progenitor (complex of Eα and Eβ components).

Discussion

The purification system we propose provides for a 10-15% yield of highly purified toxin provided culture fluid is used as base material. However, attempts to use this purification method on extracts of microbial cells did not yield satisfactory results. It must be stressed that the conditions we selected as a result of numerous tests are the optimum for obtaining a rather high yield of highly purified toxin, and replacement of the recommended buffer systems by others leads to either significant reduction of yield or appearance of additional protein components in the end product.

The purification method we propose can be used to obtain toxin in the form of precursor or directly in activated form. In the latter case, products obtained after chromatography on DEAE-cellulose must be submitted to trypsin treatment immediately prior to application to the column with sephadex G-200.

In the course of isolating a highly purified toxin from type E Cl. botulinum we obtained data consistent with the results published by Japanese researchers [2, 3, 7]. Actual toxin (component A or Eα) formed a complex with inert protein (component B or Eβ) in the acid pH range, which was dissociated into its constituents under alkaline conditions. It is noteworthy that we used a different quality of material (culture fluid instead of cells), different culture medium, strain, as well as other methodological procedures in our study, as compared to the cited authors.

The molecular weight of highly purified toxin, determined by the method of electrophoresis in PAAG in the presence of DS-Na, constituted 160,000, and it was similar to the figures known from the literature for highly purified botulinus toxins of both type E and all other known types [10]. However, analysis of the products by the method of gel filtration through sephadex G-200 yielded lower figures for molecular weight of the toxin, and they changed occasionally, depending on gel filtration conditions. When gel filtration was performed in 0.05 M acetate buffer, pH 6.0, the mol. wt. of the toxin was found to be 80,000, whereas with 0.2 M NaCl present in the eluent buffer it constituted 120,000. In the case of 0.05 M phosphate buffer, pH 8.0, the mol. wt. of the toxin was found to constitute 120,000, and it was unrelated to the concentration of NaCl in eluent buffer. Evidently, nonspecific sorption of toxin molecules on the polydextran matrix of sephadex was the cause of lower mol. wt. found in the case of gel filtration. This sorption was more marked at acid pH, and it could be partially eliminated by increasing the ionic strength of the eluent solution.

For a long time, the question of mol. wt. of Cl. botulinum type E toxin was debatable. Until recently, there were reports in the literature [8, 9] of the presence of components with low mol. wt. in toxin products of this type. In the published reports, the mol. wt. was determined by means of gel filtration through sephadex of unpurified or partially purified toxin. Thus, Emodi and Lechowich [8] reported that the mol. wt. of type E botulinus toxin, determined by gel filtration through sephadex G-200 in 0.05 M phosphate buffer at pH 6.0, constitutes 5000-9000.

In the work by Sacks and Covert [9], it is noted that preparations of type E botulinus toxin varying in degree of purification may yield two toxic components when submitted to gel filtration through sephadex G-50 and G-200 in 0.05 M acetate buffer, pH 4.5. The heavy component has a mol. wt. of ~90,000 and the light one ~12,000. Repeated chromatography of the "low molecular" component at pH 4.5 again showed distribution of toxicity in the form of two peaks. These authors conluded that it is possible for low molecular toxin to exist in equilibrated form with a polymer with higher mol. wt.

It must be noted that we observed such phenomena in our studies as well, and they were indicative of the possibility of existence of type E botulinus toxin in the low molecular form. Unpurified toxin preparations obtained from culture fuid after concentration with ammonia sulfate or polyethylene glycol came out in the form of two protein peaks with toxicity after gel filtration through a column with sephadex G-100 in 0.02-0.05 M acetate buffer. The first peak was demonstrable in a free volume, while the second was substantially retained on the column and came out with pigment in a greater volume than cytochrome c. When the second component (combined and concentrated fractions of the second peak) were again submitted to chromatography under the same conditions there was repetition of distribution of toxicity in two peaks. In some cases, all of the toxicity was demonstrable in the form of a single peak in the space corresponding to the second "low molecular" component. This phenomenon was observed with both the inactivated toxin preparation and after activagion with trypsin, and it suggested the existence of mobile equilibrium between low and high molecular forms of molecules of toxic protein.

However, it was subsequently found that this phenomenon could be unequivocally removed by increasing the concentration of eluent buffer by 5-10 times or increasing its ionic strength by addition of NaCl to a concentration of 0.5 M. Under such conditions, all of the toxicity was eluated from sephadex with a free volume [?].

On the basis of the data we obtained, we arrived at the conclusion that the described phenomena could be attributable to nonspecific sorption of toxin on the sephadex matrix in the presence of low ionic strength of buffer. In the studies conducted by the above-cited authors, the conditions were similar to ours (acid pH and low ionic strength of buffer), and we cannot rule out the possibility that the low mol. wt. levels for type E toxin we obtained were also the result of nonspecific sorption.

As can be seen in Figure 5, with isoelectric focusing of preparations of activated toxin, most of the toxicity was concentrated in the peak corresponding to pH 5.9-6.0. However, in the more acid range, at pH 4.5-4.7, we always obtained an additional peak that presented toxicity. The toxicity of the "acid" peak constituted 5-30% of toxicity of the main peak. It must be noted that a so-called "acid" peak appeared only upon isofocusing of the activated form of toxin, and it was demonstrable upon analysis of both highly purified forms and preparations recovered at the earliest stages of purification. At the present time, the nature of this phenomenon is not clear, and it will be submitted to additional investigation.

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Chemical Industry

CHEMICAL PRODUCTION ASSOCIATIONS AND TRENDS IN IMPROVING THEIR ORGANIZATIONAL STRUCTURES

Moscow KHIMICHESKAYA PROMYSHLENNOST' in Russian No 8, 1979 pp 451-457

[Article by L. P. Strakhova and M. M. Volobrinskiy]

[Text] Characteristic of the last two five-year plan periods and later periods of growth in the chemical industry has been a considerable increase in scales of production, high production concentration and more rapid rates of scientific and engineering advances. While the mean-annual growth rates for industrial output in the past five-year plan period were 11 percent and while the industry output grew 1.55 times faster than industry overall, in the current five-year plan period the chemical industry is projected to outstrip industry in general by 1.76 times, with the mean-annual growth rates amounting to 12 percent. All this predetermines the constant improvement in the management structures of the chemical industry, since the appropriate management system must correspond to its dynamic growth.

The management system of the industry and its improvement took place in several stages.

Before 1970 the chemical industry was managed by the union-republic ministry and by republic management organs. This management had major disadvantages that held back the industry's growth. The presence of the republic management organs violated the industry-by-industry principle of management and retarded the growth of specialization by subindustries. Enterprises under republic jurisdiction (about 40 percent of all enterprises in the industry) were separated from scientific and design bases. The four-tiered management system caused cumbersomeness and multiplicity in the management staffs of the industry, with a relatively low staff effectiveness, since most of the questions associated with the activities of enterprises under union-republic jurisdiction called for intervention directly by the USSR Ministry of the Chemical Industry and the councils of ministers of the union republics.

In accordance with the 1970 government decision, the chemical industry was converted to a three-tiered management system. When this was done the union-union-republic management organs were eliminated and the Main Subindustrial Administrations were transformed, since 1971, into all-union industrial associations (VPO).

At the first stage primary attention was on improving the structure of the main tier of industrial management. The general trend was to set up production and scientific-production associations. In the period from 1970 to 1972, 15 production and 3 scientific-production associations were set up in the industry. This was determined by the fact that in addition to the large chemical combines, 36.4 percent of all enterprises had a labor force up to 1000 persons; the number of enterprises with production volumes valued at up to 10 million rubles was 31.4 percent. The quite large number of small-sized enterprises materially retarded their growth, negatively affected the industry's economics and complicated the activity of higher-level organs in managing the industry.

Considering the advanced experience of the production associations set up in the national economy and in the industry, their operating effectiveness and the need for more improvements in management of the industry at all levels, in July 1974 the Ministry of the Chemical Industry formulated a general scheme for the management of the chemical industry.

The general scheme stipulated solutions to a broad spectrum of problems in improving management at all levels of the industrial management system. But, as before, first-priority attention was on improving the structure of the main tier through setting up production (PO) and scientific-production associations (NPO). The dynamics of variation in the indicators of the production concentration level in the PO (combines) and in the NPO of the industry is shown in Table 1* for the period 1970-1978.

Data recorded (Table 1) show that there is a postive trend in the growth of the number of PO and NPO in the industry, as well as in the indicators of production concentration in them. The steep climb in the number of associations in the chemical industry in 1975 was due to the fact that classified with them were the 49 combines previously existing in the industry, which were highly concentrated enterprises with specialization of constituent production facilities, which have industrial-engineering, organizational, economic, territorial and assets unity.

The associations set up in the industries are classified by us under the following characteristics: by diredtion of primary activity; by industry affiliation; by kind of production ties of the production units; and by

* Here and in the following use is made of data for the VPO and the Ministry of the Chemical Industry generalized by the authors for the period 1970-1978.

Table 1

(1) Год образования	(2) Количество объединений			(6) Удельный вес объема валовой продукции ПО и НПО к объему валовой продукции МХП, %	Удельный вес стоимости основных промышленных производственных фондов ПО и НПО по отношению к стоимости основных промышленных производственных фондов МХП, % (7)	(8) Удельный вес численности промышленно-производственного персонала ПО и НПО к численности МХП, %
	(3) Всего	(4) ПО	(5) НПО			
1970	12	10	2	7,70	4,0	5,70
1972	18	15	3	9,42	7,4	8,96
1975	77	71	6	50,60	55,4	50,37
1978	88	78	10	52,73	58,8	52,40

Key:

1. Year formed
2. Number of associations
3. Total
4. Production associations
5. Scientific-production associations
6. Proportion of gross product volume of production associations and scientific-production associations of gross product volume of the Ministry of the Chemical Industry, percent
7. Proportion of cost of main industrial fixed assets of production associations and scientific-production associations to the value of the main industrial fixed assets of the Ministry of the Chemical Industry, percent
8. Proportion of the strength of the industrial production labor force of the production associations and scientific-production associations to the personnel strength of the Ministry of the Chemical Industry, percent

degree of generalization of the production-eoonomic activity and the organizational unity of the production units.

Three kinds of associations function in the chemical industry by direction of activity: 75--production, 10--scientific-production and 3--repair-construction. All 88 territorial associations are part of 22 all-union industrial associations. From the standpoint of industrial affiliation, the existing associations are industry associations; and 32 of the inter-subindustry associations are classified as combines by the kind of production ties in the production units. The remaining 56 associations are subindustry associations; of these, 17 are combines and 39 are territorial associations of individual enterprises (firms) with different degrees of production-economic autonomy.

Classified as associations of the first kind, without juridical and economic autonomy of production units are all 49 combines and 12 firm-type associations. Associations of the second type, where the production units do not have juridical autonomy, but do have operational-economic autonomy, number six in the industry. In 12 associations, all production units have juridical autonomy (third type); the other 9 associations are of the mixed type, where the production units have different degrees of juridical and operational-economic autonomy.

Included as part of the 39 firm-type associations are 177 production units; 39 of these are the leading enterprises; juridical autonomy is retained at 68 production units; and 70 production units do not have juridical autonomy.

Analysis of the associations set up in the industry, in our view, must be conducted as follows: by the level of production concentration; by the extent of integration of the primary tier in the industry; and by the effectiveness of the production association forms used.

The proportion of production associations in the industry's total output volume and work force in 1978 was 52.7 percent and 52.4 percent, respectively. Concentrated in the production and scientific-production associations is 58.82 percent of the industry's main fixed assets. The gross output volume, per production association, was 137.5 million rubles in 1978; this is five times the value of this indicator per enterprise before the industry's structure was reorganized.

As the analysis we made showed, the scales of the production and scientific-production associations organized in the chemical industry differ widely (see Table 2).

Industry-wide, 93.5 percent of the associations have basic production-industrial fixed assets valued at more than 10 million rubles; and in 44 percent of the associations this indicator is more than 200 million rubles. The personnel force in 14 production and scientific-production associations is up to 2000 persons; in 27--from 2000 to 5000; in 33--from 5000 to 10,000; and in 14--more than 10,000 persons.

The wide spread in the scales of associations organized in the chemical industry is determined above all by their subindustry characteristics and by the forms of organization. Subindustry characteristics of associations operating in the chemical industry, from the standpoint of concentration

Table 2

(1) Группировка объединений по стоимости промышленно-производственных основных фондов, млн руб.	(2) (3) ПО	(4) НПО	(5) Удельный вес количества ПО от общего количества ПО, %	(6) Удельный вес количества НПО от общего количества НПО, %	(7) Удельный вес валовой продукции ПО и НПО в валовой продукции МХП, %	(8) Удельный вес численности промышленно-производственного персонала ПО и НПО от численности МХП, %	(9) Удельный вес стоимости основных промышленно-производственных фондов от стоимости промышленно-производственных фондов МХП, %
(10) Менее 10	5	3	6,49	30	0,7	1,2	0,17
10—25	5	1	6,49	10	1,18	1,02	0,37
25—30	5	5	6,49	50	3,35	3,29	1,3
50—100	10	—	12,98	—	5,83	3,6	2,19
100—200	18	1	23,40	10	8,6	13,6	10,00
200—500	29	—	37,66	—	25,27	22,19	33,53
Более 500 (11)	5	—	6,49	—	7,8	7,5	11,26

Key:

1. Grouping of associations by value of main industrial fixed assets, millions of rubles
2. Number of
3. production associations
4. scientific-production associations
5. Proportion of number of production associations of the total number of production associations, percent
6. Proportion of number of scientific-production organizations of the total number of scientific-production associations, percent
7. Proportion of gross production volume of production associations and scientific-production associations in gross product of the Ministry of the Chemical Industry, percent
8. Proportion of industrial-production work force of production associations and scientific-production associations of the work force in the Ministry of the Chemical Industry, percent.
9. Proportion of value of main industrial-production assets of the value of industrial-production assets in the Ministry of the Chemical Industry, percent

Table 3

(1) Подотрасль (ВПО) МХП	(2) Удельный вес ПО и НПО в общем числе предприятий подотрасли, %	(3) Удельный вес объема валовой продукции ПО и НПО в объеме валовой продукции ВПО, %	(4) Удельный вес численности промышленно-производственного персонала ПО и НПО в численности промышленно-производственного персонала ВПО, %	(5) Удельный вес стоимости промышленно-производственных фондов ПО и НПО в промышленно-производственных фондах ВПО, %	(6) Кратность среднего размера объединения по отношению к среднему размеру предприятия ВПО: (7) по объему валовой продукции	(8) по численности промышленно-производственного персонала	(9) по стоимости промышленно-производственных фондов	(10) средняя величина кратности	(11) Удельный вес специализированной продукции, выпускаемой объединениями (закрепленная за ВПО), %
Союзхлор (12)	50,0	75,4	75,9	83,1	~1,6	1,66	1,81	1,70	61,2
Союзазот (13)	60,0	~84,2	76,3	80,6	1,4	1,25	1,39	1,35	~69,0
Союзосновхим (14)	9,0	29,6	25,0	25,8	~3,2	2,75	2,84	2,94	74,9
Союзанилпром (15)	30,0	39,4	37,2	44,8	~1,7	1,61	1,79	1,70	70,2
Союзгорхимпром (16)	50,0	91,7	78,3	86,7	3,2	2,74	1,73	2,56	100,0
Союзсера (17)	20,0	48,6	46,3	~41,3	~2,4	2,31	2,06	2,26	93,7
Союзхимпласт (18)	35,7	~68,2	~60,4	~60,0	1,5	1,32	1,32	1,38	97,5
Союзхимволокно (19)	35,7	57,3	56,2	~56,4	~1,6	1,63	1,69	1,66	100,0
Союзреактив (20)	12,5	8,1	11,4	~11,2	~0,6	0,85	0,85	0,77	90,0
Союзсода (21)	27,2	40,3	38,9	~30,4	~1,5	1,42	1,31	1,40	72,5
Союзстеклопластик (22)	~6,2	15,9	10,6	17,1	~2,4	1,68	2,75	2,29	95,0
Союзфосфор (23)	80,0	91,4	91,6	90,5	~1,1	1,14	1,37	1,22	95,0
Союзкраска (24)	26,3	51,1	50,6	~31,7	~1,9	1,92	1,52	1,79	95,9
Союзкалий (25)	66,6	~91,3	86,3	91,5	~1,4	1,29	1,37	1,35	100,0
Союзхимпластпереработка (26)	18,5	37,8	42,0	~35,9	~1,9	2,10	1,79	1,92	95,0
Союзхимфото (27)	12,5	~37,1	~40,1	40,0	3,0	3,20	3,20	3,13	100,0
Союзбытхим (28)	42,0	66,8	~63,1	54,2	1,5	1,42	1,48	1,47	73,3

Key: 1. Subindustry (all-union production association) of the Ministry of the Chemical Industry
2. Proportion of production associations and scientific-production associations in the total number of subindustry enterprises, percent
3. Proportion of gross production volume of production associations and scientific-production associations in gross volume of all-union production associations, percent
4. Proportion of industrial-production work force of production associations and scientific-production associations in the industrial-production work force of the all-union production associations, percent

[concluded on next page]

[Key to Table 3, concluded]

5. Proportion of value of industrial-production assets of production associations and scientific-production associations in industrial-production fixed assets of all-union production associations, percent
6. Multiplicity of mean size of association with respect to mean size of enterprises in all-union production association
7. with respect to gross production volume
8. with respect to the industrial-production work force
9. with respect to the value of industrial-production fixed assets
10. mean multiplicity
11. Proportion of specialized product made by associations (attached to all-union production associations), percent
12. Soyuzkhlor
13. Soyuzazot
14. Soyuzosnovkhim
15. Soyuzanilprom
16. Soyuzgorkhimprom
17. Soyuzsera
18. Soyuzkhimplast
19. Soyuzkhimvolokno
20. Soyuzreaktiv
21. Soyuzsoda
22. Soyuzstekloplastik
23. Soyuzfosfor
24. Soyuzkraska
25. Soyuzkaliy
26. Soyuzkhimplastpererabotka
27. Soyukhimfoto
28. Soyuzbytkhim

of production in the associations and their mean dimensions are quite fully illustrated in Table 3.

The data recorded allow to draw a number of conclusions.

Production associations were set up in all subindustries of the chemical industry, except for the iodobromine and oxygen subindustries. Here their organization at the given stage is inadvisable owing to the extremely low level of plant concentration of production, the relatively small number of enterprises in the subindustry, the wholly closed technological cycle of some enterprises and their great dispersion across the country. The proportion associations in the manufacture of industrial products is not the same in different subindustries. This indicator is the largest in the following subindustries: nitrogen, chlorine, mining and chemical, plastics, chemical fibers, potassium, consumer chemistry and paints and varnishes.

In all these subindustries, production associations and scientific-production associations account for 50 to 90 percent of the industrial output, the value of the basic industrial-production assets and the industrial-production personnel force. Classed with the other group of subindustries with the value of these indicators from 30 to 50 percent are the following subindustries: aniline-dye, sulfur, soda and photographic chemical industry. Minimum industrial output is concentrated in production associations of heavy chemistry, reagents and glass-reinforced plastics. The actual level of centralization of industrial production in production associations in different subindustries is caused, on the one hand, by the characteristics of these subindustries from the viewpoint of the most advisable level of plant concentration and siting of industrial enterprises, and on the other--by the forms used in organizing industrial production. The largest value of the mean size of production associations, determined by the gross output, value of basic industrial-production assets and the industrial-production personnel force is in the following subindustries: nitrogen, chlorine, mining and chemical, potassium, chemical fibers and plastics. Here this is due to the high level of plant, multiunit and technological concentration and by the fact that the combine is the determining form of production associations. For the subindustries of consumer chemistry and the paint and varnish industry, with the relatively small association size for the industry, the large values of the indicators of the industrial production volume concentrated in production associations (67 and 51 percent, respectively) are due to the innovative forms of organizing production in the form of territorial production associations. At the same time we must note that as a rule in the territorial production associations that have been set up the production units have a closed technological cycle, product specialization and weakly developed internal cooperative status. In spite of the rapid growth in plant concentration of the industry, no substantive changes have happened in the specialization of its enterprises.

In this respect, relying on the analysis made [1] A. S. Wayn wrote: "For the last 15 years one specialization form--product-based specialization--has held the dominant position. And broad-profile enterprises have been and remain the dominant form. Technological and semiproduct (part-based) specialization forms have not developed. Among the combines multi-subindustry and multi-product-line enterprises are the leading kinds." Further, he noted some adverse trends observed in the forms of production organization: "Unjustified universalization of many enterprises, weak development of technological and semiproduct specialization and inter-plant cooperative status and low level of plant concentration of products of the same kind" [1]. The study conducted by the NIITEkhim [Scientific Research Institute of Technical and Economic Research of the State Committee for Chemistry of the USSR Council of Ministers] showed that the economic conditions and prospects dictate the need for radical improvements in the forms of organization of the chemical industry. In this respect trends have been noted toward a qualitatively new stage in forming the industry based on the broad development of specialization, intra-industry combination, inter-industry and inter-subindustry cooperative status and a growth in plant concentration of the manufacture of technically similar products. One way of carrying out this direction in technical policy in the industry must be seen in organizing production associations based on specialization, concentration and buildup of capacities for making technically similar products in individual production units of the associations.

The mean sizes of combines and territorial production associations in terms of concentration indicators are given below:

Indicators	Territorial Production Associations	Production Associations (Combines)
Gross product volume, millions of rubles	114.5	141.5
Value of basic industrial-production assets, millions of rubles	113.7	242.4
Strength of industrial-production personnel forces	5000	6758

Thus, territorial production associations approximate combine-type production associations in their concentration indicators.

The scales of the production associations organized in the chemical industry must be viewed both from the standpoint of indicators of the level of concentration and from the standpoint of the integration and consolidation of the primary tier. Here we must note that in the 49 associations organized on the basis of the combines the growth in the concentration of production was brought about by commissioning new and reconstructing existing production facilities, and not through integrating the primary tier.

The 39 associations in the chemical industry are territorial subindustry production associations organized by the association of two or more previously autonomous enterprises (firms). These associations account for 19.9 percent of the gross output, 18.7 percent of the industrial-production personnel force and 25.1 percent of the value of the basic industrial-production assets. From the standpoint of integration of the primary tier of the industry, the above-indicated 39 production associations took in 244 industrial enterprises and organizations; of these, 67 were eliminated as autonomous enterprises and were converted into production facilities and shops. So through improvements in the organization of management during 1968-1978, in the industry as a whole there was a 150 percent consolidation of the primary tier in terms of the number of enterprises, associations and organizations subordinated to the all-union production associations. At the present time, the number of production units in the 39 territorial production associations is 4.5.

Table 4

(1)	(2)	(3)	(4)
Фондовооруженность на одного работающего, тыс. руб. (5)	22,74	36,85	27,43
Фондоотдача (6)	1,007	0,584	0,8
Выработка на одного работающего, тыс. руб. (7)	22,9	20,96	22,0

Key:

1. Technical-economic indicators
2. Average per territorial production association
3. Average per combine-type production association
4. Average industry-wide
5. Capital-to-labor ratio
6. Capital-to-output ratio
7. Output per worker, thousands of rubles

As the analysis showed, some technical-economic indicators characterizing production effectiveness are high in territorial production associations than in combines and for the industry, on an average (see Table 4), though the extent of socialization of production in chemical industry combine is greater than in territorial production associations.

Thus, given the lower capital-to-labor ratio, the territorial production associations, when compared to the combines, have 1.7 times higher capital-to-output ratios and 8.7 percent greater output per worker, that is, the effectiveness of use of fixed assets in the territorial associations is higher than in combines and in the industry as a whole. But here we must bear in mind that in most of the territorial production associations set up the production units have basically a closed technological cycle and the levels of combination and cooperative status are slight.

At the same time, the high level of combination of production in combines affects gross output volume in the direction of its considerable reduction;

this probably strongly affects their indicators of capital-to-output ratio and labor productivity.

In addition, as noted in the study [2], the low capital-to-output ratio at major enterprises in the industry grows out of a number of other reasons, including incomplete culmination of construction, incomplete bringing of capacities up to design level and inadequate technical-economic indicators during the period of the past and the start of the current five-year plan periods.

The study we made of a number of technical-economic indicators of individual territorial production associations (of the firm type) set up in the chemical fibers industry, paint and varnish industry, plastics industry and consumer chemistry (see Table 5) showed that in most production associations, given the smaller values of their capital-to-labor ratio, there are higher indicators of capital-to-output ratio and labor productivity, both compared to the mean-subindustry indicators and with respect to enterprises not part of the production associations.

All this allows us to make a very important conclusion to the effect that organizing in the chemical industry territorial production associations based on the integration of individual enterprises as a whole has undoubtedly proven itself and positively affects the operating indicators of the industry and individual subindustries.

At the same time, some production associations of the industry are operating still with extremely low technical-economic indicators; naturally, this brings up the question of finding out the causes of this phenomenon. It can be assumed that each production association has its own causes in this respect which were not studied as part of this investigation. But what interests us are principles behind this phenomenon, not random causes. So it appears worthwhile finding out the effectiveness of different forms of existing industry associations from the standpoint of the socialization of their production and management activity, an overall characteristic for all associations.

As shown by the comparative study made of associations of different forms (see Table 5), the following trend was observed: production associations of the first kind with a high level of socialization of production and management activity (the production units that are part of the association have been converted into specialized production facilities and have been stripped of juridical and economic independent action; the management staff has been organized based on full centralization of management functions and has been set apart) have much higher indicators as to capital-to-output ratio and labor productivity than production associations of the third and fourth kinds, where the production units have juridical independent action. This is vividly illustrated by comparing associations like Yaroslavl' Lakokraska Production Association (first kind) and Ukrlakokraska Production Association (third kind), Litvbytkhim Production Association and the Ukrbytkhim and Uzbytkhimplast production associations (third

Table 5

(1) Наименование подотраслей и территориальные ПО	(2) Форма ПО по классификации	(3) Фондовооруженность		(4) Фондоотдача		(5) Выработка на одного работающего	
		(6) тыс. руб.	по отношению к подотраслевому уровню (7)	ВПО и ПО (8)	по отношению к подотраслевому уровню (7)	тыс. руб. (6)	по отношению к подотраслевому уровню (7)
Промышленность лаков и красок (в целом) (9)	ВПО (10)	20,16	1,00	2,65	1,00	53,36	1,00
Ярославское ПО «Лакокраска» (11)	Подотрасленое, территориальное, перного вида (12)	14,20	0,70	4,32	1,63	61,36	1,15
«Укрлакокраска» (13)	Подотрасленое, территориальное, третьего вида (14)	14,40	0,73	4,13	1,55	59,56	1,11
Ростовское ПО химической промышленности (15)	Подотраслевое, территориальное, четвертого вида (16)	15,21	~0,75	2,86	1,08	43,52	~0,81
Предприятия, не вошедшие в состав ПО (в целом) (16)	—	26,00	1,29	2,03	~0,76	52,81	0,98
Промышленность бытовой химии (в целом) (17)	ВПО (10)	10,88	1,00	2,30	1,00	25,04	1,00
Литвбытхим (18)	Подотраслевое, территориальное, первого вида (19)	6,37	~0,58	3,92	1,82	25,00	1,00
Мосбытхим (21)	Подотраслевое, территориальное, четвертого вида (20)	4,89	0,45	5,84	2,54	28,60	1,14
Укрбытхим (22)	Подотраслевое, территориальное, третьего вида (23)	9,81	0,90	2,92	1,26	28,60	1,14
Узбытхимпласт (24)	Подотраслевое, территориальное, третьего вида (25)	15,82	1,45	1,50	0,65	23,85	0,95
Предприятия, не вошедшие в состав ПО (в целом) (26)	—	17,74	1,63	1,27	0,55	23,38	0,93
Промышленность химических волокон (в целом) (27)	ВПО (10)	20,43	1,00	~0,98	1,00	19,86	1,00
Могилевское ПО «Химволокно» (28)	Подотраслевое, территориальное, второго вида (29)	29,82	1,46	0,95	0,97	28,28	1,42
Клинское ПО «Химволокно» (30)	Подотраслевое, комбинат, первого вида (31)	12,40	0,60	1,25	1,27	15,54	0,78
Предприятия, не вошедшие в состав ПО (в целом) (32)	—	20,31	0,99	~0,95	~0,97	19,35	~0,97
Промышленность по переработке пластмасс (в целом) (33)	ВПО (10)	11,75	1,00	1,55	1,00	18,28	1,00
Укрпластик (34)	Подотраслевое, территориальное, третьего вида (35)	11,01	0,94	1,37	0,88	15,12	~0,83
Предприятия, не вошедшие в состав ПО (в целом) (36)	—	12,97	~1,18	1,51	0,98	19,60	1,07

[Key on next page]

Key:
1. Subindustries and territorial production associations
2. Form of production association by classification
3. Capital-to-labor ratio
4. Capital-to-output ratio
5. Output per worker
6. thousands of rubles
7. with respect to subindustry level
8. all-union production association and production association
9. Paint and varnish industry (as a whole)
10. All-union production association
11. Yaroslavl' Lakokraska Production Association
12. Subindustry, territorial, of the first kind
13. Ukrlakokraska
14. Subindustry, territorial, of the third kind
15. Rostov Production Association of the Chemical Industry
16. Enterprises not part of the production association (as a whole)
17. Consumer chemistry industry (as a whole)
18. Litvbytkhim
19. Subindustry, territorial, of the first kind
20. Subindustry, territorial, of the fourth kind
21. Mosbytkhim
22. Ukrbytkhim
23. Subindustry, territorial, of the third kind
24. Uzbytkhimplast
25. Subindustry
26. Enterprises not part of the production association (as a whole)
27. Chemical fibers industry (as a whole)
28. Mogilev Khimvolokno Production Association
29. Subindustry, territorial, of the second kind
30. Klin Khimvolokno Production Association
31. Subindustry, combine, of the first kind
32. Enterprises not part of the production association (as a whole)
33. Plastics industry (as a whole)
34. Ukrplastik
35. Subindustry, territorial, of the third kind
36. Enterprises not part of the production association (as a whole)

kind) has the indicators mentioned lower in value than the subindustry-wide values. It is precisely associations of the third kind that violate the above-noted general trend of higher values for the indicators of capital-to-output ratio and labor productivity in the territorial production associations (firms) compared with the corresponding subindustry indicators.

Thus, several conclusions can be drawn. First of all, for higher production effectiveness in the chemical industry it is best to continue the work in improving the structure of the primary tier based on setting up territorial production associations (of the firm type) that include enterprises that have lower technical-economic indicators compared with existing subindustry production associations. Secondly, setting up a production association in the industry is most advisable when the highest level of socialization of production-economic and management activity will be attained, since these forms of associations (of the first and second kinds) are the most effective. In our view, setting up associations of the third kind in the industry--all the production units in associations of this kind having juridical independent action--is wholly inadvisable since in this case they function quite formally as production associations. As a rule, associations of this kind in the industry are organized on the basis of relatively small enterprises with quite simple technology, closed technological cycle and product specialization, along with considerable territorial remoteness from the leading enterprise. And the scale of the latter and the level of production organization approximate in their characteristics production units, while the extent of centralization of management functions in the association's management staff is very slight. In these cases the management staff of the association, with respect to the production units, essentially acts only as the leading management organ, approximating in its functions an all-union production association. Grouped with these associations are the Ukrbytkhim and the Ukrplastik, which includes most enterprises of the corresponding subindustry in the republic. It appears that if local conditions do not permit setting up a full-fledged production association, it is best to organize smaller associations, but with more profound specialization of production units and with greater specialization of the function of technical support, expansion and management. At the same time, this conclusion cannot be extended to associations of the fourth kind. Juridical autonomy of individual production units in associations of this kind must be looked at as a temporary phenomenon on the path of setting up a unified production-technical, economic and organizational complex. This is exactly the position of the Mosbytkhim Production Association, where the six enterprises that are part of the association have been converted into shops and two suburban enterprises are temporarily retaining juridical autonomy.

In spite of the positive trend of a growing number of production associations, there is still a fairly large number of small, broad-product-line industrial enterprises in the industry, retarding the pace of its economic development and complicating the system of industry management. The developing situation, in our view, is caused by two factors. First of all, the management staff of the Ministry of the Chemical Industry and the all-union production associations lack the functional management organs assigned to carry out supervision of systematic operation in the industry and the subindustries for improvements in management in the primary tier. This leads to a situation where problems of management improvement here are dealt with episodically, without the right kind of analysis of the most rational variants of composition and forms of the associations being set up, while the technical-economic substantiation provided at times is extremely formalistic. Secondly, the number of territorial production associations (firms) now functioning is unjustifiably small because only subindustry associations of this type are being set up in the chemical industry. L. I. Brezhnev, speaking at the 24th Congress, said: "When production associations are being set up, it is particularly important for the administrative boundaries and departmental subordination of the enterprises not to serve as a barrier to bringing in more effective forms of management" [3]. Characteristic of the chemical industry, as already remarked, is the extremely developed inter-subindustry (intra-industry) cooperative status; its enterprises are located very often in the same administrative and economic regions of the country because of their raw-material and energy resources. We also note that in the industry enormous experience has accumulated in the organizing of industrial production and management in combines that include different subindustries of the chemical industry. So there are present all the prerequisites for setting up inter-subindustry territorial production associations with a narrow technological specialization of production units and broad intrafirm cooperative status. Unconditionally, this will cut back on the number of small enterprises in the primary tier and will furnish conditions for raising the operating effectiveness of the industry.

An example of setting up an association of this type can be seen in the Voskresensk Minudobreniye Production Association, where it is advisable to add to the existing association the Podmoskovnyy Mining-Chemical Plant, in the same city as this association and supplying it with raw material for making mineral fertilizer.

Additionally, all the prerequisites are present also for setting up new subindustry territorial production associations, above all in the following subindustries of the industry: glass-reinforced plastics, heavy chemistry, chemical reagents, paints and varnishes, plastics and photographic chemical industry. It is precisely in these subindustries, as shown by analysis (see Table 3), that we find the lowest level of concentration of industrial manufacture of products in production complexes (the proportion of production associations and scientific-production associations in the total number of enterprises ranges from 6 to 26 percent) and the greatest number of small enterprises retarding the pace of the industry's expansion. Thus, in Leningrad it is highly advisable to set up a production association based on the Komsomol'skaya Pravda and Sloistyye Plastiki plants. In Kazan' there are concentrated two industrial enterprises and a scientific research institute with an experimental plant of the photographic chemical industry, which also permits setting up a production association or a scientific-production association. A gain in the level of production concentration and specialization in the glass-reinforced plastics industry is best accomplished, for example, by setting up a production association based on three Moscow-area enterprises, and in heavy chemistry--based on three Central Asian superphosphate plants.

Above we noted the role of scientific and engineering progress for the pace of the industry's expansion. Therefore, a very important factor in intensifying industrial production is the factor of drawing science closer to production and finding the organizational forms ensuring the greatest shortening of the research-production cycle. Although operating in the industry are 10 scientific-production associations that in principle measure up to this task, nonetheless in our view there are still sizable reserves. An analysis of the composition of production units that are part of the production association shows that only in four of the 75 associations are their design or project-design organizations. But in the remaining associations the responsibility for scientific and engineering progress is placed on traditional subdivisions--the central laboratory of the association (TsLO) and the planning and design section (PKO). Additionally, in associations the leading scientific research and planning organizations are called on to perform this task. The operating experience of production associations in the industry shows that most often the TsLO and the PKO are oriented in their activity toward performing the current tasks of primary and auxiliary production facilities. Introducing developments from leading institutes of the subindustry into manufacturing is dragged out for years because the "local" interests of science and manufacturing do not match up. Associations of the chemical industry that have high-output up-to-date equipment today must have the opportunity of flexibly varying the product line and the properties of products made in accordance with the demand of the national economy. Bringing this about without including in them scientific-engineering centers is practically impossible. At the same time most leading scientific research institute and planning organizations have their branches, located in the centers when the major industrial production of the subindustry (combines and associations) is concentrated. So it appears advisable to include as the most important direction in raising the effectiveness of production associations in the industry and thus intensifying industrial output, as part of the largest production associations--with the rights of production units--subindustry scientific research, design and planning and technological design organizations (branches and laboratories of leading institutes). Setting up these scientific-engineering centers as part of the production associations will enable them to more rapidly introduce the developments of the leading institutes of the industry and to perform current tasks of the associations in the specialization of production units, expansion of the product line, upgrading of product quality and cutting product costs.

Experience with associations and firms of socialist (German Democratic Republic and Poland) and capitalist countries (Federal Republic of Germany, Japan and the United States) confirms the advisability of this direction.

One of the most important directions in raising the effectiveness of existing and newly organized production associations in the chemical industry is a profound and comprehensive substantiation of the composition of production units included in the associations, their product lines, capacities, specialization and cooperative status. It is precisely these characteristics that determine the extent of industrial-engineering unity of the production units of associations, which--ultimately--determines the choice of the organizational form of management in the association and its organizational structure. In turn, this unity can be brought about only by designing a unified production process in the association whose methodological bases were spelled out in a series of studies by the TsNOTkhim [Central Scientific Organization of Labor and Production Control in the Chemical Industry] [4]. Thus, designing the production process must precede the development of an organizational structure, including the production structure and the structure of the association's management staff. The higher the extent of industrial-engineering unity attained in the enterprises that are part of the association based on their specialization and cooperative status, the greater can be the extent of their organizational unity based on higher centralization and specialization of services taking part in the production process, as well as the services of the association management staff.

Formation of the production structure of an enterprise (association) is a constituent part of the designing of the entire management system. The production structure embraces the subdivisions of basic production as well as subdivisions by their support and services for carrying out the production process. In this respect we must note that at the present time a series of studies has been done concerning the problem of organizing and forming the structures of repair services in associations at enterprises in the chemical industry [5,6]. At the same time the industry lacks well-defined regulations spelling out the conditions for the formation of basic-production subdivisions and their status. The unambiguous interpretation of the limits to a technological department, shop or production facility often leads to cumbersomeness in production structures of associations because of the large number of subdivisions and management levels. This complicates intershop and intra-shop ties and the controllability of the production process and heavily expands the staffs and costs for maintaining the management staff in production subdivisions. Thus, working out a methodological approach and determining, on its basis, regulating the conditions for organizing subdivisions in basic production of different scales (department, shop and production facility) is among the first-priority tasks aimed at raising the effectiveness of production structures of enterprises (associations) in the chemical industry.

At the present time, when 75 industrial production associations of different organizational forms are operating in the industry and when definite trends have appeared in the organization of their production and management, the objective necessity has come to the fore and the opportunities have come to light for developing and introducing model structures of the management staff of production associations in the chemical industry and their constituent production units. Use of model structures built on the basis of general inter-industry principles of management organization in the national economy with consideration of industry and subindustry characteristics of the organization of industrial production and the advanced experience in the production associations of the industry in management allows us to form management staff structures on a unified methodological basis. At the same time, model structures must not become a barrier to developing the management system of associations in connection with the dynamic growth of industrial production typical of the industry and the possible appearance in this respect of qualitatively new purposes and tasks posed before the management system. With allowance for the requirements outlined, "Model Structures of the Management Staff of Production Associations and Enterprises in the Chemical Industry" was formulated and confirmed by order of the minister of the chemical industry on 1 Feb 79.

The past decade was a period of substantial rearrangement of the structure of the primary tier in the chemical industry. Production associations of different organizational forms occupied one of the determining places in this structure. Their operating experience showed that this form of organization of industrial production as a whole has fully justified itself; setting them up promoted higher operating efficiency in the industry. The favorable experience accumulated in organizing management in the production associations and certain negative trends brought to light allow us to believe that the period ahead must become a period of substantial rise in their operating effectiveness.

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THE NIUIF PLANT IS FIFTY YEARS OLD

KHIMIYA V SEL'SKOM KHOZYAYSTVE in Russian No 9, 1979 pp 3-5

[Article]

[Text] The NIUIF [Scientific Research Institute of Fertilizers, Insecticides and Fungicides imeni Ya. V. Samoylov] State Union Experimental Plant was started up in October 1929, on the eve of the First Five-Year Plan, in the year of the great change on all fronts of socialist construction. That period was characterized by intensive development of the chemical industry in our country. Giants of the fertilizer industry--Berezniki, Solikamsk, Voskresensk, Bobriki [presently Novomoskovsk], Chernorechneskiy and other complexes were built and started up. There was a broad scope of geological exploration work to find agronomic ore. Unique deposits were discovered of apatite in Khibinskiy, sylvinite and carnallite in Solikamsk and Bereznikovskiy, and somewhat later equally large deposits of phosphorite, borate, pyrites, arsenic and sulfur in Karatau. Within a short period of time, the chemical industry of our country, and first of all the mineral fertilizer industry, obtained a strong domestic raw material base.

Investigation of the agronomic ore discovered in our country and development of the technology for processing it into fertilizers constituted a difficult set of scientific research and experimental engineering tasks, the fulfillment of which was assigned to the staff of the Scientific Institute of Fertilizers (presently the NIUIF) founded with the approval of V. I. Lenin.

The first heads of this institute, Prof Ya. V. Samoylov and Academician E. V. Britske, who realized that the institute needed an experimental-testing base, undertook development thereof actively. Thanks to their efforts and persistence, construction of the Experimental Plant was successfully completed.

During the prewar years, the staff of the institute and Experimental Plant did much work dealing with the study of agronomic minerals (phosphites, apatites, sylvinites, carnallites, carbonaceous pyrites and others). Successful studies were pursued of problems of crushing, grinding and enriching the minerals (flotation, magnetic separation and others). The data obtained at this plant were used in designing large concentration [enrichment] factories at the Verkhnyaya Kama, Yegor'yevskiy and other mines, the world's largest phosphorite mills in Shchigry, Polpino and Voskresensk.

Development of the technology for conversion of the nation's superphosphate industry from phosphorites to apatite should be listed among the complex problems that were resolved at that time.

Giving priority in their work to problems of development of the fertilizer industry (superphosphates, dicalcium phosphate [precipitate], ammophos [ammonium phosphate fertilizer], diammonium phosphate), the plant staff was active in developing the technology of chemical processes and production (of extraction and heat-treated phosphoric acids, sublimation of phosphorus in electric and blast furnaces, boric acid, phosphoric anhydride, selenium, alimentary sodium phosphates, etc.).

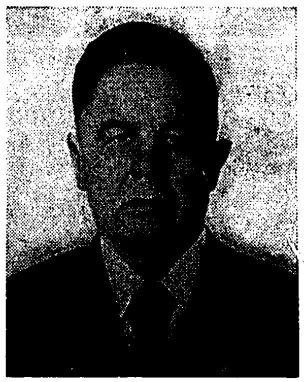
Experimental work dealing with 23 new production processes implemented on an industrial scale at 10 enterprises of our country (Voskresensk, Konstantinovsk, Vinnitsa, Odessa, Perm', Chernorechenskiy, Aktyubinsk, Kirovo, imeni Baturin, Dneprodzerzhinsk, Stalingrad, Kerch', NIUIF and others) was completed at the plant in the prewar years with beneficial results. At that time, S. I. Vol'fkovich, S. K. Voskresenskiy, N. N. Postnikov, L. V. Vladimirov, A. A. Sokolovskiy, N. D. Talanov, I. I. Makartin, Ye. Ye. Zusser, L. Ye. Berlin, Ye. A. Vetchinkin, V. S. Gerdler, A. P. Meshkov, A. Ye. Belova, N. D. Golikov and many other specialists famous for their contribution to Soviet and worldwide science worked at the plant with particularly fruitful results.

The war interrupted the peaceful labor of the plant staff. Under the guidance of the MGK [Moscow City Committee of the CPSU and Zhdanov's RK [?] of the CPSU, the plant was energetically converted to meet the needs of the front.

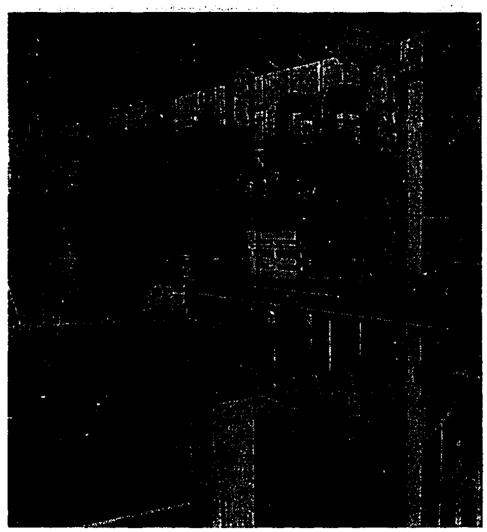
A total of 205 plant employees joined the field forces, and 46 of them fell on the battlefields.

The front needed effective weapons against tanks. Within an exceptionally short period of time, the plant set up the production of the antitank incendiary mixutre, KS. The nation's defense industry experienced an acute need for calcium carbide. The plant adapted its furnaces for sublimation of phosphorus to production of calcium carbide and set up such production.

Production of Mazhef [manganese ferric phosphate] was set up, this is an agent that protects ammunition and military equipment from corrosion. Production of activated pyrolusite for electric batteries for front-line radio equipment and other communications equipment was organized.



V. I. Bannikov, director of the NIUIF Experimental Plant



Ammophos production using a method without drying.

The plant converted to production of incendiary ammunition in collaboration with the Ordnance Department of the People's Commissariat for Defense.

The enemy was routed and overthrown by the heroic efforts of the Soviet people organized by the Communist Party. Then came the postwar period. As early as 1946, the plant returned to its peacetime production to meet the needs for restoration of the national economy.

In the postwar period, the plant staff concentrated on development of new technological systems and refining existing ones for recovery of mineral fertilizers, acids, salts and other chemical products (compound fertilizers, feed phosphates, boric acid, catalysts, herbicides, metaphosphoric acid and pyrophosphoric acids, liquid fertilizer, crystallin, new products for motor vehicle plants and washing agents).

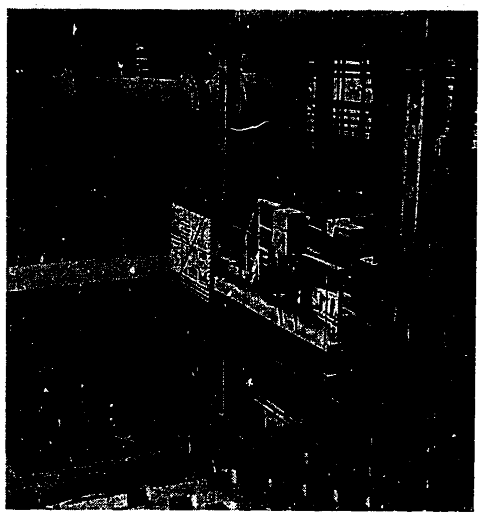
At the present time, tens of millions of tons of a wide assortment of mineral fertilizers, hundreds of thousands of tons of acids, salts and other chemicals are being produced in the nation on the basis of the developments, in which the staff of the Experimental Plant participated actively and creatively. In the last 20 years alone (1958-1978), 47 new production processes, which were refined at the Experimental Plant, were adopted on a mass industrial scale at 25 plants.

For many years, this plant has been developing dynamically and working with success. The plant fulfilled the production program of a seven-year plan (1959-1965) in 6 years, that of the 8th Five-Year Plan (1966-1970) in 4 years and a half, that of the 9th Five-Year Plant in 4 years and 8 months, and that of 3 years of the current, 10th Five-Year Plan was fulfilled by the 61st anniversary of the Great October Socialist Revolution.

Complete remodeling of the plant was performed in 1968-1975. General plant administration has been updated. The reconstruction made it possible to create a new and quite modern plant at the old site. Real scale experimental units have been developed, and this has increased immeasurably the role of the plant as an experimental scientific base, as well as its contribution to development of technological progress in this field.

Working and environmental conditions have improved for the personnel, and efficiency of labor has increased. In addition to previous measures (housing, well-lighted shops, greenery, lounges, dining room, club, reading rooms, medical sections, Pioneer camp, nursery, creches, permanent space in sanatoriums), the reconstruction has opened the way for progressive development of the plant for many more years. Sanitation problems have been resolved. The quality of products has improved (in 1978, 54.4% of the products were awarded the "Mark of Quality").

In all the years of existence of the plant, its staff and social organizations developed and refined the forms and content of socialist competition, as a tried and true method of overcoming difficulties and educating the personnel in the spirit of the program theses of the Party. According to the results of quarterly evaluation of the outcome of socialist competitions, in the past 20 years the personnel of this plant were judged the winners of socialist competitions 59 times among enterprises of the chemical industry and 34 times among enterprises of Zhdanovskiy and Lyublinskiy rayons of Moscow. In 1963, the title of "Enterprise of Communist Labor" was conferred upon the plant, in 1972 "Enterprise of Highly Sophisticated Production" and in 1977 "Exemplary Enterprise of the City of Moscow." The employees have been entered in the Honor Book of the CPSU MGK, Mossovet, Moscow City Council of Trade Unions and MGK of the Komsomol.



Unit for producing nitroammophos by different methods

The achievements of many progressive people at the enterprises have been recorded forever in the glorious labor records [chronicles] of the plant. Having already given decades of creative labor to the plant, the following individuals are still serving there, augmenting the reputation of the entire staff: N. M. Bakanova, N. P. Kryuchkov, V. F. Silakov, V. S. Kholin, A. G. Yebdokimova, K. P. Golubeva, Ye. B. Mel'nikov, M. M. Tsetlina, V. A. Sartakov, V. M. Granovskiy, V. D. Podkopayev and many others.

Complex measures, aimed at continued advancement of the personnel in all work sectors and attaining higher achievements, were developed and are being implemented by the plant personnel in response to the high titles bestowed upon them. These measures enrich the plan for social development of the enterprise, filling it with new content.

The Department of Chemistry of the CC CPSU, Ministry of the Chemical Industry, CPSU MGK, Soyuzosnovkhim All-Union Association and administrative bodies of Lyublinskiy Rayon of Moscow rendered operational guiding assistance to the plant with regard to performance by the plant personnel of the tasks put to them, dynamic development of the plant and practical implementation of the decisions of the 25th CPSU Congress.

The plant personnel are totally ready on the plant's 50th anniversary to work with even greater effort in the future for the noble pursuit of developing Soviet chemical science and industry.
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