Conference on Problems of Concentrating Nonmetallic Minerals by Flotation

Izvestiya Akademii Nauk SSSR, Otdeleniye tekhnicheskikh nauk, No 3, pp 466-472, Russ mo per

CONSULTATION ON THE PROBLEMS OF DRESSING NON-METALLIC ORES BY THE METHOD OF FLOTATION

A consultation devoted to the problems of concentration of non-metallic ores by the flotation method took place from 10 to 13 October 1950 at the Mining Institute of the Academy of Sciences USSR. Participating in the proceedings of the conference were 170 scientific contributors from the Academy of Sciences USSR and the branch research institutes; engineering and technical personnel from operating plants, as well as from the managing and planning organizations of the mining industry (from 42 organizations), also participated.

In his introduction, Academician A. A. Skochinskiy emphasized the exceptionally important value to the development of Soviet science of the brilliant works of Comrade Stalin in the field of language studies. He then proceeded to summarize the progress and the problems of science and industry in the area of flotation of mineral ores, and went on to outline the program of work for the conference. The flotation of non-metallic ores attained a wide application in the USSR. The flotation processes for graphite, apatite, nepheline, calcite-fluorite-scheelite, baryto-fluroite, quartzitic kyanite, kaolino-diasporic ores, and talcum from the magnesitic varieties of talc schists have been

completely mastered. The flotation of coals and the penta-component kyanito-langbeinitic ore, and other ores is being mastered. Thus, a vast flotation industry has been created in the area of non-metallic ores. The successes attained in our land in the theory and practice of the flotation type of ore dressing have been generally recognized.

He made mention of the research by A. N. Frumkin and P. A. Rebinder in the physical chemistry of flotation, and that of I. N. Plaksin in the theory of the concentration processes, wetting and interaction between reagents and mineral particles during the flotation process, and in the floto-gravitational processes; he pointed out that the studies of these workers now constitute the theoretical basis for the correct understanding of the fundamental phenomena of flotation.

In conclusion, A. A. Skochinskiy called upon the participants of the conference to develop a comprehensive scientific discussion on the posed problems of flotation, in keeping with the guidance of Comrade Stalin, to the effect that no science can develop and prosper without a conflict of opinions, without freedom of criticism.

Academician P. A. Rebinder read a report on the subject of "The measurement of peripheral angles and their relation to flotation."

He pointed out that the direct adhesion of mineral par-

ticles to the air bubble with the formation of a three-phase moistening perimeter, i.e., with the formation on the surface of the mineral particle of an end peripheral angle in the presence of the pellicular water remaining beneath the air bubble is now a universally recognized fact; this fact has been established primarily through the labors of Russian scientists. A. N. Frumkin and B. P. Kabonov have shown that the formation of the peripheral angle is the sole factor determining the fundamental action of the flotation process -- the adhesion of the mineral particles to the air bubble. They have shown the effect of the electrocapillary, adsorption, and chemical factors upon the momentary value of the peripheral angles and upon the kinetics of their evolution. The kinetics of adhesion are linked to an abruptly-occurring surmounting of a certain energetic barrier. The Soviet scientists L. V. Volkova and M. A. Eygeles established the fact that very frequently the attainment of a negligible peripheral angle is fully sufficient for the inception of the flotation process. Closely connected with this is the work of V. I. Klassen, who demonstrated the importance of the two-dimensional gas embryo as a new phase forming on the surface of the floatable particles. The reporter underscored the importance of the wetting hysteresis, as a result of which, under the effect of the adsorption of the collecting oil, there is a sharp increase in the peripheral angle to a magnitude at which the strong adhesion of the mineral particles to the air bubble becomes possible. The chemico-sorptional coatings of the mineral surface and their stability are the material base which determines the corresponding

degree of hydrophobia of the mineral surface, with its end peripheral angles and its area of contact with the air bubble providing for the adhesion of the mineral particle to the air bubble.

Corresponding Member of the Academy of Sciences USSR I. N. Plaksin read a report on "The theory of flotation as of today" (the report is printed in this journal).

M. A. Eygeles (the All-Union Institute for Mineral Raw Materials) read a report entitled "The Principles of the Depression of Non-Mettalic Minerals in the Flotation of Ores." The speaker indicated that the depression of the minerals, not designated to be floated, is the most important factor in the highest selectivity of the flotation process. In connection with this, he studied the reciprocal action of a number of regulating agents (depressants) upon the adsorption of oleinic acid by the mineral particles and upon the floatability by the same collecting reagent. As a result of this research, the absence was established of a well-defined ratio between the density of the layer of the collecting reagent upon the facets of the minerals and the floatability of the minerals in an actual flotation circuit. The flotation of the mineral particles takes place in the presence of an incomplete monomolecular layer of the collecting reagent on their facets (a 30 to 40 percent covering of the facets by the collecting reagent is adequate for a high recovery). Thus, the concept is rejected that the depression reduces itself to the reduction in the amount of the collecting reagent adhering

to the mineral facets. In reality, the action of the depressors is more varied and complex. The adsorption of the depressor ions increases the degree of hydration of the mineral facets, resulting in the retardation or the complete cessation of the adhesion of the particles to the air bubble.

O. S. Bogdanov (the Institute for the Mechanical Treatment of Ores "Mekhanobr") reported on the "Physico-Mechanical Effect of the Density of the Flotation Pulp and of the Waste Rock Content in Flotation." As a result of research it was established that

(1) The degree of mineralization of the air bubbles in the presence of the ratio T : Zh = 1:111, 1 : 55, 1 : 28.8, 1 : 18 (by weight), is approximately directly proportional to the concentration of the mineral being recovered in the pulp, for the particle sizes investigated (60 -- 15 microns).

(2) The degree of mineralization of the air bubbles is inversely proportional to the specific gravity of the particles and inversely proportional to the diameter of the air bubble (which did not exceed 2.8 millimeters).

(3) The presence of [waste] rock reduces the degree of mineralization of the air bubbles and, consequently, the productivity of the flotation machinery.

To this same group of reports belongs the communication by I. I. Kurenkov on the subject of the "Gravity-Flotation Method of

Concentration of Non-Metallic Ores," in which the fundamentals of this method were analyzed, and the design of the machinery involved and some results of its industrial application were discussed.

L. A. Grekulova (VIMS), in the discussions that followed the above reports, cited additional experimental data characterizing the regularity of the flotation process in an actual pulp. It was established by research that each point in the flotation machine, regardless of the operation and height of the cell, the air bubbles carry on their surfaces considerable numbers of mineral particles. As the bubbles move upward, the number of the mineral particles on them increases up to 186 grams per liter of air, becoming, however, reduced in the sub-froth product to 143 grams per liter of air. The bubbles in the vertically central part of the flotation cell carry the greatest number of large mineral particles (74-147 microns and above), as compared with the lower part and the sub-froth layer. The number of fine mineral particles (0-20 microns) is the same in all zones. The degree of mineralization of the bubble surfaces in the first cell of basic flotation is 40 percent; the amount of tailings in reflotation is 5 to 6 percent. In the lower cross section of the cell (the zone of the impeller), the air bubbles are mineralized selectively, following which their characteristics change very little.

V. A. Mokrusov (VIMS) pointed out that the time is here

when all processes must be broken down into component elements, reducing themselves to atomic-molecular interaction. Had this thesis been accepted, there would have been no dispute such as that concerning the chemical reaction versus the physical interaction, the contrasting of which with relation to the theory of solutions was condemned first by D. I. Mendeleyev and later by N. C. Kurnakov. In connection with this, V. A. Mokrousov told a story about the error he fell into: "In 1947 and 1948, while analyzing the problem of the interaction of xanthogenate with the surface of a mineral, I considered the increase in the strength of the intermediate bonds to be a result of the resonance of valences. Such a viewpoint is fundamentally in error, in the light of the erstwhile discussion, which proved that, in reality, no such conditions exist -- conditions which, in accordance with that thesis, should have predominated." He noted further that V. A. Glembotskiy, without any basis in fact, is utilizing the flotation procedure for the study of the heterogeneity of the surface of mineral particles. Furthermore, a number of the V. A. Glembotskiy theses, which are being criticized, are characteristic of most of our theoretical research. V. A. Glembotskiy is continuing his active work pertaining to the theory of flotation, promoting and defending new working theories, while at the same time some scientists do not bring forth any theoretical generalizations, obviously hesitant to criticize the already-known and previously-published theses. In evaluating the book by M. A. Eygeles, The Fundamentals of the Flotation of Non-Sulfide Min-

erals (Metallurgizdat, 1950), V. A. Mokrousov pointed out that the author "did not cope successfully with the synthesis," since, in the analysis of the problems under study, he did not set forth the clear atomic-molecular concepts. As a result, there are two disconnected parts in the book (the interaction between the minerals and the air bubbles, and the interaction between the minerals and the flotation reagents).

O. S. Bogdanov ("Mekhanobr"), participating in the discussions, touched upon the significance of the peripheral angles and expressed a doubt toward the deductions made by Frenkel' and Aron with relation to the same problem.

D. C. Yemel'yanov (Leningrad Mining Institute) took note of the thesis on the flotation process originally presented by K. F. Beloglazov; the general premises of this thesis can hardly be disproved, since they are based on the energetic process of adhesion of the particles to the air bubble. According to D. C. Yemel'yanov, remarks without any basis in fact were admitted with relation to the factor characterizing the adhesion of the mineral particles to the air bubble ϕ , and with relation to the number of air bubbles N, passing through the pulp. K. F. Beloglazov does not completely deny the importance of the peripheral angles, and his theory, according to D. C. Yemel'yanov, is the first attempt to connect the elementary act of flotation with technological conditions, which attempt must not be disregarded. However, some premises in Beloglazov's theory remain unclarified.

V. I. Klassen (Mining and Chemical Raw Material Institute) reported on the great importance of determining the peripheral angles of moistening. He designated this method as the indicator method of floatability determination. In quoting from the contents of the P. A. Rebinder report, he indicated that the theses by Frenkel' and Aron, in this part, were linked with a misunderstanding through considering the angle of moistening as a function of the pull. Then, in dwelling on the book by K. F. Beloglazov, V. I. Klassen asserted that some individual "flotational-philosophical" premises of Beloglazov's are unacceptable, and that the method of analyzing the elementary stages must not be set off against the analysis of the process by the final results of flotation. The methodological premises of K. F. Beloglazov may result in the wrong orientation of other researchers.

S. A. Kuzovlev (Tashkent) proposes to study the flotation process on actual ores, utilizing the method of physico-chemical analysis of equiponderant systems, developed in the study of the equiponderant salt systems by N. S. Kurnakov.

N. T. Leviush (VIMS) pointed out that the contradictory views on the effect of the pulp density upon the indexes of the flotation process was the reason for research on the effect of the pulp density upon the rate of flotation of particles of various sizes. In experimenting with pure minerals, it was discovered that fine particles (approximately 52 microns) are better floated

in pulps of higher density. In diluted pulps, the flotation of coarser particles is accelerated sharply. With a further substantial increase in the density of the pulp, the rate of flotation of all sizes of particles is retarded. This is due to the fact that the air bubbles are heavily loaded, and do not take on the entire amount of the mineral particles present in the pulp. K. F. Beloglazov explains this phenomenon by a surplus of the collecting reagent in the pulp of high density, which results in the retardation of flotation. This assertion N. T. Leviush considers to be in error. She maintains that, in the presence of a 50 percent density of the pulp, calculations show an insignificant covering (17 to 18 percent) of the mineral surfaces by the collecting reagent, under which conditions it is wrong to assume the presence of an excessive amount of the collector, but it is correct to assume the presence of its greatest concentration. In this case, the flotation of the coarser particles should predominate, yet, the reverse is the case.

Continuing her argumentation, N. T. Leviush took issue with the statement by Beloglazov to the effect that the density of the pulp does not affect the rate of flotation. If his point of view is accepted, a view maintaining that the principal role is played by the expenditure of the concentration of the collecting reagent, then, in the presence of a diluted pulp, the flotation of the coarse particles should be diminished. Whereas experiments reveal specifically that in diluted pulps the relatively coarse particles show a maximum rate of flotation.

V. A. Glembotskiy (Mining Institute of the Academy of Sciences USSR) dwelt upon the reports of Academician P. A. Rebinder and of Corresponding Member of the Academy of Sciences USSR I. N. Plaksin. He pointed out the great value of these reports, their thorough and correct evaluation of the theory of flotation as of today. In replying to some of the critical remarks relating to his theses on the theory of flotation, on the heterogeneity of the surface, and on the interaction between the minerals and the reagents, V. A. Glembotskiy disagreed with the assertion of the critics that his these do not touch upon actual problems. On the contrary, as a result of his research, in which due consideration was given to the heterogeneity of the surface, the following highly important results were derived.

A rational method for the collecting reagent charge, and a corresponding simple device, resulting in a higher recovery and a higher flotation rate, with a simultaneous reduction the collecting reagent consumption, were developed. The effect of intermixing with the reagent upon the rate and the results of flotation were studied. Methods of determining the optimum charge of the collecting reagent, for the purpose of intensifying the process, were developed. All these are essential and are of great interest to the industry.

In reply to V. M. Mokrousov, he pointed out that he did not study the heterogeneity of the surface per se, but only the effect of the heterogeneity of the surface of the minerals upon

the kinetics of flotation, and the results of this effect.

V. A. Rundkvist ("Mekhanobr") pointed out that, in the realm of flotation theory, Soviet science has overtaken the science of other countries. As proof of this, he referred to a recently-published article by Sutherland pertaining to the mineralization of the air bubbles in the pulp counter-current, the deductions of which article are the same as the ones arrived at by O. S. Bogdanov.

G. P. Slavnin (The Irkutsk Mining and Metallurgical Institute) touched upon the problem of floto-gravitational concentration, ascribing great importance to this process and praising the initiative displayed by the Mining Institute of the Academy of Sciences USSR for introducing the process into industry. The difficulties encountered by inventors and designers in developing apparatus that will provide for aeration on the surface of the concentration table can be surmounted. Experiments conducted in the laboratories of the Institute with many ores of various sizes and specific gravities (quartz-apatite, graphite-garnet ores, etc) revealed that the effect of concentration, in the presence of aeration near the surface of the concentration table, is increased considerably, as compared to the case when aeration is used ahead of the concentration apparatus.

L. I. Stremovskiy (Institute of Mining and Chemical Raw Materials) indicated that, with relation to the development of an advanced theory of the flotation process, no methods for the

solution of a series of problems are, as yet, available. However, the V. A. Glembotskiy theses constitute the least vulnerable target for criticism. The assertions that they do not contain any elements of practically applicable value are without foundation in fact. On the contrary, the problems discussed in the Glembotskiy theses, particularly those relating to the flotation of mineral particles of various sizes, are of great practical interest.

I. N. Shorsher ("Mekhanobr") dwelt upon the importance of theoretical and experimental research in flotation and emphasized the particular importance of ever wider experimentation.

Corresponding Member of the Academy of Sciences USSR I. N. Plaksin called the attention of flotation-machine designers to the necessity of designing machines that would provide maximum recovery. A machine with a higher capacity is of less importance to the People's economy than a machine providing for greater recovery.

The second group of reports was devoted to the flotation of the Donbas coals.

M. G. Yel'yashevich (Donetsk Industrial Institute) reported on the "Flotation of the Donbas Coals." As a result of research into the floatability of coal tailings from a number of shafts, coal dust and slimes from a number of central concentration mills, it was revealed that floatability improves with the

increase in the clarenic ingredient and drops with the predominance of the durain and fusain components. The effect of flotation is linked to the characteristics of the ore body. For instance, limestons and coarse-grained argillaceous shales are not transformed into the frothy product; coal shale frequently remains in the tailings; epigenetic concretions, imparting hydrophilic properties to the surface of the coal, are formed in the process of flotation. It is rational to use as flotation reagents the dephenolized products of the fractional distillation of coke tar and the dephenolized oils of the semicoke coal shale, and brown coal tars (various distillation fractions). The flotation of classifier fractions less than one millimeter in size is effective. The flotation cycle has been clarified, and other important problems studied.

V. A. Koybash (Donetsk Industrial Institute) reported on "The Selection of the Most Advantageous Type of Flotation Machine for the Flotation of Coal." This thesis was preceded by two other theses relating to the selection of a most advantageous flotation machine for the flotation of coal fines and to the operational tests of individual flotation machine designs. Three types of machines were tested: the FM--2.5 flotation machine of the mechanical type with bottom-feed of the pulp, aeration and agitation of the pulp effected by a turbine-type aerator; the FM--[redacted] machine, designed at "Mekhanobr", with an improved type of aerator; and the FM--DII machine, designed at the Donetsk Industrial Institute. The primary tests revealed that for the flo-

tation of the run-of-the-mine coal fines (dust and slimes), the mechanical (not the pneumatic) type, and particularly the impeller type, is the most suitable machine. These results were subsequently checked in a more thoroughgoing manner on the above-enumerated three machine types. The results were as follows: the first place was assigned to the FM--DII machine (however, due to the short testing period, it is premature to recommend this machine to the industry); the second place, to the FM--30 machine; and the third place, to the FM--2.5 machine.

In the deliberations that followed these reports, representatives of the Donbas coal industry, Z. S. Blagova and A. P. Zherdev, reported on the results of the flotation of coal fines, on the shortcomings, and on the current problems. They criticized the Central Research institutes for their lagging behind in the development of the theory of flotation, particularly in the branch pertaining to the concentration of coal and to the solution of the problem of low-cost, transportable, and effective collecting reagents. They called for an acceleration in the tempos and for the design of improved equipment for the concentration of fine coals, also for the overcoming of the deficiencies in the existing flotation machinery.

N. A. Aleynikov (Moscow Mining Institute) evaluated the importance of the already-completed research in the field of the flocculation phenomena in the process of concentration by the use of the flotation method and gave due credit to the work of M. G. Yel'yashevich and V. A. Koybash. He took note of the fact that a

period of 15 years has elapsed since the study of flotation machinery began, but no valid theory has been developed as yet. In order to accelerate progress in this field, it is necessary to centralize these problems in the Mining Institute of the Academy of Sciences USSR.

V. I. Klassen criticized the local scientific personnel of the coal industry for the gap created between the availability of reagents at the flotation mills and the actual needs for them, which gap could be closed by proper planning during the period of the scientific development of the problem. He had high praise for the labors of the Donetsk Industrial Institute directed toward the problem of flotation of coals and the improved design of flotation machinery.

G. P. Slavnin raised the problem of the necessity for the selective concentration of coal, proceeding from the consideration of coal as a poly-mineral raw product. He maintained that a concentrate with a 7 to 8 percent ash content is not good enough. The ash content, as revealed by the work of the Institute, conducted with the minimum expenditure of collecting reagents and with the utilization of collector-free flotation, can be reduced to 3 to 4 percent.

L. I. Stremovskiy recommended that the Mining Institute of the Academy of Sciences USSR take the leadership in guiding the young flotation branch of the coal industry, and obligated himself to participate personally in the development of the problem

of selective flotation of the finely-dispersed coal particles.

V. I. Trushlevich (Moscow Mining Institute) criticized the efforts of certain comrades proclaiming the necessity for the creation of a separate theory for the flotation of coal. The theory of flotation should be a general one for all mineral ores. The trouble with coal-concentration research and with the selection of the most suitable flotation machinery for coal concentration is the absence of a unified plan.

Corresponding member of the Academy of Sciences USSR I. N. Plaksin supported the criticism of Z. S. Blagova and A. P. Zherdev, who pointed to the lag in the flotation theory, particularly with reference to the flotation of coal. He maintained that there is a simultaneous lag in the technology of coal flotation. Flotation losses, already mentioned before, cause considerable damage to the People's economy, and they must be eliminated. At the present time the mechanization of mining has come into its own, rendering the value of coal flotation even more important. In connection with this, I. N. Plaksin mentioned the available possibility of converting part of the coals used for the production of power to metallurgical use by the method of petrographic concentration.

The third group of reports dealt with the problems of the new technology of concentration of individual varieties of non-metallic ores.

V. I. Klassen made two reports: "Concentration by Flo-

tation of Hydro-Boracitic Ores" and "Concentration of Vitreous Sands." In the first report, he pointed to the fact that all attempts to separate by flotation gypsum from hydroboracite, both of these having a high solubility, failed because of the close floatability of these minerals by the conventional reagents and because of the negative effect upon flotation of the finely-dispersed argillaceous fractions. As a result of research, the possibility of the selective flotation of gypsum and hydroboracite was established. Simultaneously, it was clarified that the negative effect of the argillaceous slimes is linked to their solid phase, and methods for the elimination from the system of the finely-dispersed clay were discovered. Thus, the complex problem of the selective flotation of hydroboracitic ores was brilliantly resolved by Soviet scientists.

The second report maintains that quartzitic sands in glass manufacturing make up from 60 to 70 percent of the charge, and that the quality of the glass depends primarily on the quality of these sands. The needs of the industry manufacturing conventional and technical glass, particularly the automotive and other branches of industry, are linked to a production of glass of higher translucene and thickness, which becomes possible only through the availability of sands with an iron oxide content of around 0.03 percent. In connection with this, the necessity arose for the development of a rational procedure for the obtainment of pure quartzitic sands. The characteristics of this procedure consist in that, during the floto-abrasive concentration, the

grains of the extraneous materials are guided into the tailings, with the simultaneous elimination of the iron hydroxides from the quartzitic grains. Thus, a rather important problem was successfully solved.

E. P. Sheblo (the Ministry for the Industry of Building Materials USSR) reported on "The Results of Research and Industrial Experimentation with the Flotation of Talcum from the Talcum-Magnesite Varieties of Talc Schists." It must be pointed out here that American business interests unscrupulously utilized the attainments of Soviet scientists. In the State of Vermont, United States of America, a flotation mill was built in which the technological flow sheet for the concentration of low-grade talc-magnesitic ores is a replica of the flow sheet developed in the USSR.

L. M. Chernyy (Institute for Mining and Chemical Raw Materials) reported on the "Concentration of Carbonaceous Phosphorite Ores." These ores consist basically of phosphate, carbonaceous minerals, and chalcedony. The concentration of these ores is made complex by the identity of the cations of the phosphate of calcite and dolomite, their floatability by anion reagents, and by the fine reciprocal penetration of the minerals. The concentration problem for this ore was solved by a combination of the flotation and the chemical concentration processes.

L. I. Stremovskiy reported on the "Separation of Salt Mixtures by Flotation," emphasizing thereby that the process of flo-

tation passed on from the field of metallurgy into the field of purely chemical industries by promoting the successful separation of soluble salts. To date, conditions have been established for the mutual separation of alkaline chlorides, sodium and potassium sulfates, and nitrates. Conditions for the separation of tri-salt mixtures and bisulfates from rock salt are being investigated. The flotation of tetra- and penta-component mixtures is rendered complex by the necessity for choosing selective reagents for a considerable number of minerals and of the time interval for the establishment of a state of equilibrium in the flotation medium. An example of such a complex system is the kyanite-langbeinitic ore. In the case of this system, the speaker established the fact that, under conventional conditions of flotation, in a medium which is not completely saturated by some of the minerals in the ore composition, but is completely saturated by others, there occurs a transformation of the first into the second. As a result of these processes, a multi-component system is ultimately transformed into a new system with a lower number of components. Thus, one of the possible solutions of this problem is to conduct flotation in a medium which is not completely saturated by certain of the ore components. On the basis of experiments already completed, a technological ore dressing flow sheet, which produced positive results on a pilot scale at the mine, has been developed.

During the deliberations, comrades V. A. Mokrousov, V. A. Rundkvist, and others gave a high evaluation to the work of V. I.

Klassen and L. I. Stremovskiy, assuming that the results of their experience will be applied in developing ore-dressing methods to other varieties of mineral ores.

N. P. Shlayn (the Glass Institute) also dwelt in detail upon the same reports, emphasizing in particular the importance to the glass industry of the results obtained by L. I. Stremovskiy, since the natural deposits of some mixed salts call for the separation of their composition into separate components (which can now be performed very simply). In referring to the second report by L. I. Stremovskiy, N. P. Shlayn pointed to the fact that the newly-recommended method of treatment for vitreous sand excludes the previously proposed methods of treatment, which were varying with individual natural ore deposits. The new method is the same for all types of sand and is simple in its equipment prerequisites. The current problem confronting the scientist is to discover a method for the complete elimination from the vitreous sands of iron oxides and admixtures of manganese, nickel, cobalt, chromium, which are present in the sand in negligible quantities.

P. P. Titov (Tomsk Polytechnical Institute) reported on the experiment for the concentration by flotation of kyanite ores. These ores are the raw materials for the manufacture of high-grade ceramics and other products. Laboratory and pilot tests revealed the rationality of substituting these raw materials for aluminum and silicon derivatives. He also reported on the positive results of the flotation of graphitic ores.

Corresponding Member of the Academy of Sciences USSR I. N. Plaksin dwelt upon the works of L. I. Stremovskiy, which he considered to be of great importance to the theory of the flotation process, particularly regarding the effect of salt solubility upon the adhesion to the flotation froth and regarding the solubility of the collecting agent in a given medium. In analyzing these ratios, I. N. Plaksin emphasized the fact that some scientists attempt to construct the theory of flotation by proceeding from some single regularity, which method is in error. The adhesion of the solid particles to the flotation froth occurs in a selective manner, in conformity with a number of regularities. Hence, the adhesion to the flotation froth is, in all cases, due not only to changes on the surface, or to purely adsorptive, or purely chemical, or, finally, chemico-sorptional interaction. This phenomenon may occur as a result of various chemical, physico-chemical, or physical phenomena developing on the surface. Touching upon the effect of the solubility of the collecting reagents in a given medium, I. N. Plaksin makes the assumption that an important part is played in this case by reversible adsorption. Seemingly, during the flotation of soluble salts, there is no sorption tied in with the non-reversible process of reagent fixation, a process which is characteristic for most cases of flotation.

S. M. Yasyukevich (the Moscow Nonferrous Metals and Gold Institute) delivered a communication on the "Terminology in the Field of Concentration of Mineral Ores," in which he emphasized

that, while the concentration of mineral ores occupies an important place in the national economy of the USSR, there is as yet no standardized terminology for this branch of science and industry. In addition, the field is partially handicapped by foreign non-expressive terms, while clear-cut fatherland terms are available. Thus, the problem of a standardized terminology in the field of concentration of mineral ores must be faced. S. M. Yasyukevich proposed, as a basis for this terminology, the use of the technological index, characteristic for a given machine, apparatus, process, or method.

V. N. Kostrov, representative of the Committee on Technical Terminology of the Academy of Sciences USSR, suggested that the unquestionably valuable work of S. M. Yasyukevich in the field of terminology be treated as a vocabulary. The research begun in this field requires methodological rectification and polishing, since the final purpose of a practical terminology is to establish a system of correct single-meaning terms of strictly-defined concepts. This basic characteristic of a scientific terminology has not yet found its full expression in the work presented.

Others who took part in the discussion of all the above reports and communications were I. M. Verkhovskiy, M. G. Yel'yashevich, I. I. Kurenkov, I. M. Nesterov, M. A. Eygeles, and S. M. Yasyukevich.

In summarizing, the consultation took note of the fact

that the successful development of the flotation methods of ore dressing for the non-metallic ores in our country is an indisputable fact. The attainments and progress made in this field by the toilers of the Soviet mining science and industry are due primarily to the brilliant guidance of Comrade Stalin, emphasizing the importance of theory and its close ties with empirical methods, the necessity for the constant critical revision of out-of-date concepts and traditions, and the development of scientific criticism.

The work of the consultation took place against a background of mutual cooperation between the scientific and production personnel, of the introduction of new techniques, as developed by research, of assistance in the solution of production problems, and of coordination of further scientific research.

The deliberations that followed the reports, as well as the reports themselves, establish the considerable attainments of Soviet scientists in the theory of flotation, particularly in developing the fundamentals for the flotation of non-sulfide minerals. However, the general state of the theoretical activities in the field of flotation were pronounced by the consultation to be unsatisfactory.

The consultation took note of the valuable initiative displayed by the Mining Institute of the Academy of Sciences USSR in sponsoring the consultation and of the considerable organizational work conducted by the Institute and by the Chairman of the Orga-

nizational Committee, the Corresponding Member of the Academy of Sciences USSR, I. N. Plaksin. The expansion of the work of the permanent seminar on the concentration of ores was also recommended.

The resolutions which were adopted took further notice of the fact that the work of the Mining Institute of the Academy of Sciences USSR, as reported to the consultation, marks a new orientation in the study of the interaction of gases and flotation reagents with the surface of the mineral particles (the I. N. Plaksin report). This is of particular importance in the concentration of non-metallic ores (phosphorites, arsenical ores, sulfur, etc). The development of gravity flotation methods (the I. I. Kurenkov report) is also of considerable interest in the case of non-metallic ores and merits a wider introduction accompanied by the application of new apparatus, particularly for concentrates of a predetermined size (apatitic-quartzitic-diapsidic ores, graphite, ilmenite concentrate, etc).

The all-embracing study by VIMS (M. A. Eygeles and others) of the effect of reagents, primarily collectors and depressors, and by "Mekhanobr" (O. S. Bogdanov) of the ratios between the degree of mineralization of the air-bubble surfaces and the concentration of minerals in the flotation pulp are of great importance to the national economy. Research by the Institute for Mining and Chemical Raw Materials (V. I. Klassen) was instrumental in solving the problem of hydroboracite flotation. The study of the

flotation-froth separation of highly-soluble salts (L. I. Stremovskiy) attests to the great possibilities for the use of this method in the concentration of ores and precipitation salts, also in the concentration of the products of chemical technology [processing industries]. Research by L. M. Chernyy in the concentration by the use of flotation methods of carbonaceous phosphorite ores is important. With all the above, however, the utilization of research results in actual industrial production is insignificant.

In order to attain a rapid solution pertaining to the general problems of the theory of and the improvement in the flotation of non-metallic ores, it is recommended that the research activities be developed in the directions indicated below:

The study of the mechanics and regularities of the interaction between the minerals and the reagents, gases, etc; the study of the elementary actions of flotation; the expansion of the nomenclature of the flotation reagents being manufactured. The necessity for a wider introduction into industry of the improved "Mekhanobr" flotation machines is indicated. The coordination by the Mining Institute of the Academy of Sciences USSR of the scientivic activities along the critical problems of the flotation theory is to be accelerated. The terminology in the entire field of ore dressing is to be standardized.

The consultation called upon all the leading research institutes to provide advice and guidance to the branch and peri-

pheral laboratories as well as to individual scientists.

A number of miscellaneous decisions were also adopted by the consultation

Reported by I. I. Kurenkov

END