Report on the Conference on :

NON-RENEWABLE RESOURCES—SURFACE CHEMISTRY AND MINERAL PROCESSING.

This is the first time that ECSI has organized a Conference of this type, bringing out the role of electrochemistry on the surface properties and behaviour of minerals and on the processing of minerals. The two-day Conference was inaugurated by Dr. C. S. Pichamuthu, President of the Geological Society of India, at 10.00 hrs on April 6, 1977. Professor K. P. Abraham, welcomed the gathering and Professor K. I. Vasu, the Chairman-Coordinator of the Conferente proposed a Vote of thanks.

Professor P. Somasundaran, of the Henry Krumb School of Mines, New York, also the Associate Editor of the Journal, took a commanding role in the Conference giving keynote addresses or special lectures and leading the discussions on: Theories of grinding, fine particle treatment and selective flocculations, dewatering of slow-settling sludges, physico-chemical aspects of flocation and other mineral beneficiation techniques, and current researches to meet the world's mineral needs.

There were 20 papers presented in the seven sessions spread over two days. Intense and lively discussions took place after the presentation of each paper. Abstracts of the papers are given below.

Prof. P. Somasundaran summed up the proceedings

At the end of the sessions, there was a panel discussion on the theme: Is there a case for Interdisciplinary Course in Minerals Engineering? The panelists were: Prof. P. Somasundaran, Prof. K. P. Abraham, Prof. C C. Patel. Prof. R. Kumar, Dr. K.A. Natarajan, Shri G M. Rao, Dr. N.P. Srivastava, Shri B. Srikantan.

There was a consensus on the need for starting an integrated, interdisciplinary course in minerals engineering at the Masters level.

The last session of the Conference witnessed a special feature, the presentation of the Ramachar Award—1976, for the best paper published in the Journal of the Electrochemical Soceity of India, Dr. S. Krishnamurthy, President of the Society, presented the Cash Prize and the Award for the best paper and the awards of Certificate of Merii for the next two best papers (see Editor's page, April issue)

Along with the Conference, the Annual General Body Meeting of the Society was also held. Members suggested that the Annual General Body Meetng should every year be preceded by an Annual Technical Meeting of the Society.

1. PROBLEMS AND RESEARCH NEEDS IN NON-RENEWABLE RESOURCES AREA

P. Somasundaran

Henry Krumb School of Mines, Columbia University, New York (now at IISc)

Minerals are the foundation stones of our present machine civilization, and today we see in most parts of the world our high grade ore reserves getting depleted at an ever increasing pace Technology to treat tomorrow's ores, which include in part today's waste, does not yet exist. Even fundamental information needed to develop the required technology does not fully exist. How can we meet this challenge? Some of the major problems in the area of both non fuel and fuel resources will be discussed here and typical on-the-horizon solution will be examined.

2. PERSPECTIVE PLANNING AND UTILISATION OF MINERAL RESOURCES OF KARNATAKA

G. S. Annaiya

Director, Department of Mines and Geology, Government of Karnataka

Karnataka state has been fortunate in possessing a number of economically important mineral. The chief among the minerals exploited are gold, iron ore, manganese ore, chromite, bauxite, limestone and copper ore. Besides these, there is wide variety of minerals awaiting utilisation in Industry. Judicious care is to be exercised for utilising these mineral resources as resources as these will get exahusted, once they are mined and used. Planned development of the mineral resourses is being attempted only in recent years. There is increasing awareness on the preservation and judicious use of important mineral resources and intensive search is being attempted by utilising the modern aids.

Beneficiation and utilisation research on minerals is gaining popularity day by day due to the availability of larger tonnage of low and marginal grades of ores. The expanding mineral-based industries need supplies of larger tonnage of minerals and ores in order to sustain increasing demands. With the depletion of deposits of

higher grade minerals and ores, the utilisation of leaner grades assumes importance and sometimes becomes inevitable. Every attempt should be made to make use of the vast mineral resources of low grade by research and beneficiation and thereby conserving the country's mineral resources

3. CONSERVATION OF NONRENEWABLE SCARSE MATALLIC RESOURCES USING CERAMICS

P. K. Rohatgi, M. K. Surappa and Deo Nath

Department of Metallurgy and Mechanical Engineering Indian Institute of Science, Bangalore.

This paper discusses the conservation of non-renewable and scarce metallic resources like Copper, Tungsten, Lead, Zinc, Chromium and Tin by using particulate composites. These composites consist of a metallic matrix of one of the more abundant metals, like iron or aluminium, in which particles like graphite, mica, alumina, clay and silicon carbide are dispersed using a relatively simple and inexpensive foundry techniques. The wettability between the ceramic particles and liquid metals, the rate of flotation of these particles in the liquid metals, and the interaction between moving solid-liquid interfaces and these particles are some of the important parameters which effect the production of such particulate composites. These composites can be used as bearings, pistons, and cutting tools.

The paper will be concluded with a discussion of some other opportunities of possible conservation of non-renewable metallic resources through the use of renewable and abundant materials.

4. INTERFACIAL PROCESSES IN FLOTATION

P. Somasundaran

Henry-Krumb School of Mines, New York (now at IISc.)

Flotation of mineral particulates is the result of adherence of air bubbles with which they come in contact in the flotation cell. In the past such adherence has been described to take place if the surface of the particle is naturally hydrophobic or if the surface is atleast partially converted to that state owing to adsorption of reagents that contain nonpolar parts. The role of adsorption of these reagents on the bubble surface itself has however been ignored. In this talk the important role of adosption at the liquid/air interface will be emphasized with the help of data obtained for surface tension properties of collector solutions. Our study of dynamic surface tension properties has also thrown considerable light on the role of ionomolecular surfactant complexes in flotation. Formation of these highly surface active complexes is suggested to be phenomenon that governs the pH dependence of hematite flotation using oleate and of quartz flotation using amine. Additional correlations obtained recently for flotation with surfactant complex formation suggests the new theory based on the role of such complexes in froth flotation to be of wide application.

5. BENCH SCALE BENEFICIATION STUDIES ON COMPLEX COPPER-LEAD-ZINC ORES

G. M. Rao, Subrahmanyam and Bhargava

Indian Bureau of Mines, Nagpur

A general survey is presented of the results of the laboratory investigations carried out in Indian Bureau of Mines on flotation of complex copper-lead-zinc samples from the deposits of Ambamata, Gujarat; Mamandur, Tamil Nadu; Daviba-Rajpura, Rajastan; and Rangpo, Sikkim. The results are briefly discussed. The need for hydrometallurgical studies for extraction of the metal values is also indicated.

6. SLIMES IN FLOTATION—THEORETICAL AND PRACTICAL ASPECTS

K A. Natarajan

Department of Metallurgical Engg.
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Various types of slimes involved in flotation are characterised. Problems associated with slime formation with respect to flotation are discussed. Practical aspects of the slimes problems in the flotation of various oxide minerals are illustrated. Particular emphasis has been made to typical Indian conidiions.

7. DEWATERING AND CLARIFICATION IN SLOW-SETTLING SLUDGES

P. Somasundaran

Henry Krumb School of Mines, New York (now at IISc)

The dewatering of slow settling mineral sludges is a problem of much practical and theoretical significance. The practical importance lies is the need for the disposal of such sludges in an environmentally acceptable form and in the need for recovering the water for recirculation. The mechanism of sedimentation of colloidal slimes has been investigated in our study using model systems and natural systems. The macroscopic mechanism of subsidence or dewatering is derived by

considering the effects of movement of coarse particles and air bubbles through the gelled slurry creating paths for seepage of water. The movement of air bubbles and particles through the slurry alters the physical conditions of the slurry by creating tears, fissures and long channels for easy seepage of water. The microscopic mechanism, responsible for the stability, or lack of it, of phosphatic slime was investigated by formulating model systems. During the process of formulation of the model system, the role of each mineral in determining the behaviour of sludges was revealed. Shape, properties of swelling, surface charge and viscosity are all governing properties determniing the dewatering characteristics of different suspensions.

Batch sedimentation curves upon analysis showed presence of several regions, each region indicating a specific sedimentation mechanism which predominates over a concentration range. Phenomenological models for the regions are proposed and expressed in their simplest mathematical form. The resulting equations consisting of logistic, logarithmic, and exponential decay terms fit data within experimental error.

8. ANALYSIS OF A FOAM-BED REACTOR

Jyotirmay Biswas and Rajinder Kumar

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Indian Institute of Science Bangalore-12

On the basis of dodecahedral structure of a foam-bed a model for a foam-bed reactor has been developed. To verify the proposed model experiments have been caried out in a semi-batch apparatus for the absorption of lean CO_2 gas in a foam of sodium hydroxide solution. The proposed model predicts fairly well the experimentally found absorption values.

9. FLOCCULATION AND CLARIFICATION OF MINERAL SUSPENSIONS

S. Subramanian and K. A. Natarajan

Department of Metallurgy,
Karnataka Regional Engineering College,
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The increasing emphasis on the utilisation of lower grade iron and base metal ores has resulted in the necessity of much finer grinding for the liberation of valuable minerals before an effective separation and concentration is possible. This fine grinding results in the formation of considerable amounts of slimes, consisting of both valuable minerals and gangue. Further, mining operations produce larger amounts of fines. Clarifica-

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tion of these slimes is becoming highly imperative for prevention of stream and lake pollution, and for water reuse in the plant. Further-more, the large volumes of water involved are a reservoir for chemicals, which if returned to the process, could substantially reduce reagent costs.

This paper rewiews the study of the flocculation and clarification of mineral suspensions, taking iron oxides and associated gangue minerals as particular examples. The factors of importance in promoting effective flocculation and clarification of mineral suspensions are outlined. Theoretical and practical aspects of selective flocculation and reclaiming techniques are discussed.

10. NOTE ON THE BENEFICIATION OF BARYTES FROM GATTIHOSAHALLI, HOLALKERE TALUK, CHITRADURGA DISTRICT

G. S. Annaiya and S. P. Dharanendran

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Department of Mines and Geology, Government of Karnataka conducted the survey and exploration for barytes in the vicinity of Gattihosahalli of Holalkere taluk with a view to assessing the barytes for commercial exploitation. The mineral is associated with granitic gneisses. The barytes analyse from 66.27 to 88.14 of $BaSO_4$.

Beneficiation tests were conducted in the Mineral Technology Laboratory of the department to upgrade the same for 90% of $BaSO_4$ for use in oil well drilling.

Results were encouraging with a recovery of 45% of the bulk analysing 90.85% of $BaSO_4$.

Baryte ($BaSO_4$) has varied uses and is playing an important role in chemical, paints and oil well drilling. India is also rich in this mineral. Notable deposits are in Andhra Pradesh and Rajasthan. In Karnataka this mineral was discovered recently in Gattihosahalli amidst quartzite.

11. A SURVEY OF PRESENT DAY AUTOGENOUS MILLING PRACTICE

I. G Reddy

Chief Metallurgist, Chitradurga Copper Co., Chitradurga Karnataka.

The paper surveys the historical development and present day practice of Autogenous Milling i.e. size reduction of solids by 'Rock grind itself'.

In conventional milling practice, the run of mine ore is steadily reduced to the desired fineness by a series of size reduction steps involving primary and secondary crushing and coarse and fine grinding by using metallic grinding media such as alloy steel rods and balls. The wear of metallic grinding media makes the conventional milling operation very expensive. With the advent of Autogenous grinding the metal wear of grinding media is reduced partially or fully depending upon whether the operation is partially or fully autogenous.

It has been brought about that potentialities are immense for adopting autogenous methods for new plants or for conversion of already existing conventional milling plants.

12. BENEFICIATION OF PETROLEUM COKE FINES — PART I

B. C. Pai, Scientist,

Materials Division, National Aeronautical Laboratory, Bangalore--17

and

U. B. Nayak

Department of Metallurgy, Indian Institute of Science, Bangalore--12.

Beneficiation of petroleum coke fines containing 3.47% total ash has been attempted by (1) wet screening (2) simple acid leaching and (3) heavy media separation processes. Beneficiation to eliminate silica and other impurities in the fine size range from 60 mesh (BSS) to 150 mesh (BSS) by simple wet screening of these fractions has not been successful. Acid leaching of +85 mesh (BSS) fraction gave a product of 0.396% inherent ash content and a yield of 82.80 from bulk. Heavy media separation of +150 mesh (BSS) fraction increased the yield to 87.80% from bulk with an inherent ash content as low as 0.188%. Results from large scale sink and float tests have been very encouraging. The distribution of silica in the fine size range below 22 mesh (BSS) opens up further possibility of beneficiation of coke by a combination of heavy media separation and flotation process.

13. BENEFICIATION OF HIGHLY SILICIOUS IRON ORE FROM GOA

K. M. Pai and V. Narayan
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The ore assayed 40.8 percent total iron, 38.1 percent silica and 0.78 percent alumina. This had to be upgraded to 60 percent Fe and 10 percent SiO_2 and 1 percent Al_2O_3.

Liberation size was found to be 10 mesh (1.672 mm). Hence all the ore particles were crushed to −10 mesh and the whole sample was divided into a coarse (+100 mesh) and a fine (−100 mesh) fraction.

Tabling and wet magnet separation were tried for the +100 mesh and flotation was tried for the −100 mesh fraction.

Magnetic separation gave better results (65.5 percent Fe and 69 percent recovery) than tabling (62.01 percent Fe and 67 percent recovery) and flotation gave 59.3 percent Fe and 17 percent recovery. Mixing up the magnetic separation and flotation concentrates gave a final grade of 64 percent Fe with 86 percent recovery.

The capital cost involved in setting up the plant is also estimated.

14. BENEFICIATION OF KYANITE ORE FROM SARGUR SCHIST BELT, MYSORE DISTRICT : A CASE STUDY

K. S. Raghuveera, R. L. Gaikwad,
C. Gopala Swamy Rai, and G. S. Annaiya.
Department of Mines and Geology,
Government of Karnataka.

High grade metamorphic schists of Sargur belt in Mysore District of Karnataka include linear and lenticular enclaves of metapelites. One of the major rock types of this group comprises varying quantities of Kyanite and sillimanite which, when available in seggregated patches may become a source of raw material for manufacture of high grade alumina refractory bricks. Average samples drawn from two prominent outcrop areas were subjected to refractory tests and X-ray diffraction analysis. The sample from Mallesvaranbetta area showed better efficiency as a refractory raw material. Kyanite and sillimanite which impart refractory property to the sample occur as mineral constituents of the rock type. It varies from 62.4 to 77.4%. Experimental work which included grindability tests, micrometric analysis, gravity separation on a Wilfly table, heavy media separation and magnetic separation indicated that concentration of kyanite and sillimanite could be carried to 85.2%.

15. PROCESSING OF CHALCOPYRITE CONCENTRATES : FERRIC CHLORIDE LEACHING AND GALVANIC CEMENTATION

S. Ilangovan, T. G. Prakash, J. Balachandra and K. I. Vasu
Metallurgy Department, Indian Institute of Science Bangalore.

Ferric chloride is an excellent oxidative leachant for chalcopyrite. At 105°C under vigorous agitation, chalcopyrite dissolves in ferric chloride as follows :

$$CuFeS_2 + 3FeCl_3 = CuCl + 4FeCl_2 + 2S$$
$$CuFeS_2 + 4FeCl_3 = CuCl_2 + 5FeCl_2 + 2S$$

The copper in the leach liquor is cemented out by a baser metal, scrap iron being one of the cheapest. Direct, two stage cementation gives a fairly good crop of copper; the purity is improved by the novel technique of galvanic cementation.

This technique involves adiaphragm cell where a copper electrode is kept in the leach-liquor catholyte and scrap iron is kept in the anode compartment containing dilute ferrous chloride, and the two are short-circuited when iron dissolves in the anolyte and an equivalent amount of copper is deposited from the catholyte, as in a Daniel Cell. The copper deposited is not contaminated with any iron, and the purity is always greater than 99%.

Investigation on the practical aspects of galvanic cementation has revealed that the rate of deposition depends on anolyte acidity, catholyte concentrations, cathode and anode areas, and cell resistance. Small inter-electrode distance, low ferric and high copper concentrations in the catholyte, and unit anode-to-cathode area ratio are some of the operating conditions which lead to high rate of galvanic cementation.

16. USE OF METALLURGICAL BACTERIA IN THE RECOVERY OF METALS FROM WASTE RESOURCES

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Different types of bacteria that are useful in metal extraction from waste mineral resources are illustrated. The characteristics and types of these bacteria are brought out. Particular reference has been made to the sulphur and iron oxidising type of bacteria, Thiobacillus Ferrooxidans in the solubilisation of copper from waste copper resources.

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