



DEPARTMENT OF
ENERGY, MINES AND RESOURCES
OTTAWA

MINES BRANCH

SCIENTIFIC AND TECHNICAL PAPERS

PUBLISHED BY THE STAFF IN 1972

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FOREWORD

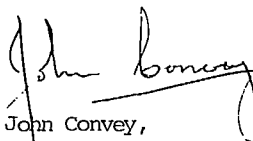
Information Circular IC 151 (June, 1963) was the first in a series of annual reviews of the scientific and technical papers published by the staff of the Mines Branch. This Information Circular IC 298 is the tenth supplement to IC 151 and is divided into three sections.

Section 1 consists of the titles and abstracts of papers published during 1972 in the Mines Branch Series (Monographs, Research Reports, Technical Bulletins, Information Circulars and Reprint Series). These reports are available from Information Canada, Ottawa, at the prices indicated, and may be ordered by the catalogue number given for each report. (Pre-1962 reports are listed in Canadian Government Sectional Catalogue No. 12, July 1962).

Section 2 lists the titles of all papers published in scientific and technical journals during 1972 by the Mines Branch staff. The periodicals containing these papers are available in many technical libraries.

Section 3 contains a list of the 1972 titles available in the Investigation Report Series and also of the titles from previous years that now have been released for general distribution. This series includes the results of investigations done by the Mines Branch at the request of industry, of other government agencies, and of investigations initiated by the Mines Branch of specific materials and processes. Many Investigation Reports are not available because they are either confidential or of very limited interest. Those that are listed in the Information Circular are available for reference, in the divisional files, but in most cases there are no copies remaining for distribution. However, it is felt that even this limited availability will be of value to many individuals or companies with specific interests and will help prevent unnecessary duplication of investigations already made by the Branch.

I hope that this supplementary index will be as well received as the first in this series and that it will provide the reader with a more complete view of the work of the Mines Branch in aiding Canada's mineral and metallurgical industries.


John Convey,
Director.

AVANT-PROPOS

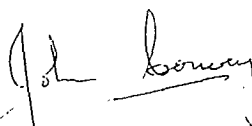
La Circulaire d'information IC 151 (juin 1963) était la première d'une série des revues annuelles des travaux scientifiques et techniques publiés par le personnel de la Direction des mines. La présente circulaire IC 298 qui comprend trois sections est le dixième supplément à IC 151.

La première section comprend les titres et les résumés des travaux publiés en 1972 dans les séries de la Direction des mines (monographies, rapports de recherches, bulletins techniques, et circulaires d'information). On peut obtenir ces différents rapports chez Information Canada, à Ottawa, aux prix indiqués, en les commandant d'après leur numéro au catalogue. (La liste des rapports publiés avant 1962 figure dans le Catalogue partitif n° 12 du gouvernement canadien).

La section 2 comprend les titres de tous les travaux publiés par la Direction des mines en 1972 dans les revues scientifiques et techniques. Encore ici, un résumé de l'étude accompagne chaque titre, afin de donner au lecteur un aperçu de la teneur. Les périodiques où paraissent ces travaux sont à la disposition du public dans plusieurs bibliothèques techniques.

La section 3 énumère les titres des travaux qui ont paru dans la série des Rapports d'Investigations en 1972 et auparavant qui ont été rendus publics. Cette série comprend les résultats des recherches effectuées par la Direction des mines à la demande de l'industrie et d'autres services officiels, ainsi que les résultats des recherches entreprises par la Direction des mines sur des matériaux et procédés déterminés. Plusieurs de ces Rapports d'Investigation ne peuvent être disponibles à cause de leur nature confidentielle ou du peu d'intérêt qu'ils présentent. Ceux qui sont énumérés dans la présente circulaire d'information peuvent être consultés dans les archives des diverses divisions, mais, dans la plupart des cas, il n'existe pas d'exemplaires pour la distribution au public. Cependant, on estime que même cette disponibilité limitée est de nature à favoriser de nombreux particuliers ou des sociétés qui s'intéressent à des domaines très précis et contribuera à éliminer le double emploi inutile en ce qui concerne les recherches déjà effectuées par la Direction.

J'espère que cet index supplémentaire sera aussi bien accueilli que les précédents dans cette série et qu'il présentera au lecteur un inventaire plus complet des travaux effectués par la Direction des mines au service des industries minérales et métallurgiques canadiennes.


John Convey,
Directeur.

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SECTION 1 - MINES BRANCH SERIES

RESEARCH REPORTS

R 237

Crystal Growth Part III: The Sulphides of Cobalt, Iron, and Nickel

Leonard G. Ripley*

This report deals with an applied research project to explore the various methods of preparing and growing single crystals of twenty-two different sulphides of cobalt, iron, and nickel.

Five growth procedures have been utilized. They are: chemical vapour transport, vapour transport, flux growth, hydrothermal growth, and a modified "melt-and-anneal" method.

The main conclusions are that:

- (i) the melt-and-anneal method is ideal for the high-temperature form of nickel monosulphide (a-NiS) and for pentlandite ($\text{Fe}_{0.5}\text{Ni}_{0.5}\text{S}_8$);
- (ii) the iodine vapour transport is a good method for preparing monoclinic pyrrhotite (Fe_{1-x}S), cattierite (CoS_2), pyrite (FeS_2), and vaesite (NiS_2);
- (iii) the hydrothermal growth procedure will produce marcasite (FeS_2), greigite (Fe_3S_4), and bravoite ($\text{Fe}_{0.5}\text{Ni}_{0.5}\text{S}_2$);
- (iv) the flux growth, using PbCl_2 as the flux, has produced cattierite (CoS_2), pyrite (FeS_2), and vaesite (NiS_2), but the crystals contained approximately 1% Pb as inclusions of PbCl_2 ; all attempts to eliminate this problem have been unsuccessful.

Ce rapport traite d'un projet de recherche appliquée pour étudier les différentes méthodes de préparation et de croissance des monocristaux de vingt-deux différents sulfures de cobalt, de fer et de nickel.

On a utilisé cinq procédés de croissance: le transport chimique en phase vapeur, le transport en phase vapeur, la croissance par la méthode des fondants, la croissance hydrothermique et une méthode modifiée de "fondre-et-recuire".

Les principales conclusions sont les suivantes:

- (i) la méthode "fondre-et-recuire" est idéale pour la forme du monosulfure de nickel (a-NiS) à haute température et pour la pentlandite ($\text{Fe}_{0.5}\text{Ni}_{0.5}\text{S}_8$);
- (ii) le transport en phase vapeur de l'iode est une bonne méthode pour préparer la pyrrhotite monoclinique (Fe_{1-x}S), la cattierite (CoS_2), la pyrite (FeS_2) et la vaesite (NiS_2);
- (iii) le procédé de croissance hydrothermique produira la marcassite (FeS_2), la greigite (Fe_3S_4) et la bravoite ($\text{Fe}_{0.5}\text{Ni}_{0.5}\text{S}_2$);
- (iv) la croissance par la méthode des fondants, utilisant PbCl_2 comme fondant, a produit la cattierite (CoS_2), la pyrite (FeS_2) et la vaesite (NiS_2) mais les cristaux contenaient à peu près 1% de Pb en tant qu'inclusions de PbCl_2 ; tous les essais pour éliminer ce problème n'ont pas réussi.

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R245

Elevated-Temperature Peeling Failure of Galvanized Coatings

J.J. Sebisty* and D. Papenfuss**

The elevated-temperature peeling failure of conventional galvanized coatings was investigated with the object of defining the factors which influence and control the process.

Two different heating deterioration modes revealed were found to be dependent on the chemical composition of the coating. Above a critical limit of 0.001% Pb, the outer zinc layer separated in the characteristic manner, and similar failure was induced by alloying with bismuth, indium, thallium, and tin. Below this lead limit and with additions of aluminum, cadmium, magnesium, nickel, silver, vanadium, and zirconium, the coating remained completely intact and the outer zinc layer gradually disappeared by diffusion dissolution. The rate of both reaction modes was primarily influenced by the time and temperature of heating and the coating thickness.

Mechanisms which attempt to account for the peeling process are reviewed and an alternative explanation is offered which is more nearly consistent with the observed facts.

Practical implications of the results are discussed, inclusive of transformation effects in the iron-zinc alloy layers which relate to the kinetics of the galvanizing reaction.

On a fait des recherches approfondies sur la desquamation à haute température des revêtements galvanisés conventionnels ayant pour but de définir les facteurs qui influencent et contrôlent le procédé.

On a trouvé que deux modes différents de détérioration à la chaleur dépendaient de la composition chimique du revêtement. Quand la teneur en plomb dépasse la limite critique de 0.001% la couche extérieure de zinc se sépare de façon caractéristique, et un phénomène semblable se produit quand on y allie du bismuth, de l'indium, du thallium et de l'étain. Quand la teneur en plomb ne dépasse pas cette limite le revêtement reste complètement intact et la couche extérieure de zinc disparaît graduellement par diffusion avec l'addition de l'aluminium, du cadmium, du magnésium, du nickel, de l'argent, du vanadium, et du zirconium. La vitesse de réaction des deux modes a été influencée essentiellement par le temps et la température du chauffage et l'épaisseur du revêtement.

On passe en revue aussi les différents mécanismes utilisés pour essayer d'expliquer le procédé de desquamation et on offre une explication alternative qui est plus logique si on se base sur les faits observés.

Enfin on discute les implications pratiques des résultats, incluant les effets de transformation sur les couches d'alliage fer-zinc ayant rapport à la cinétique de la réaction de galvanisation.

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**Formerly Research Metallurgist, Canadian Zinc and Lead Research Committee.

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R246

The Hydrocracking of Residual Oils and Tars 1: The Effect of Feed Dilution on the Thermal Hydrocracking of Athabasca Bitumen

E.C. McColgan*, R.G. Draper** and B.I. Parsons***

The paper describes recent work at the Fuels Research Centre on the development of a hydrocracking process for upgrading heavy fuel oils and tars. Elements of hydrogenation and thermal cracking processes have been combined in a continuous flow system to pretreat the residuum and generate distillable streams more amenable to secondary catalytic hydrogen refining. The oil is heated slowly in the presence of hydrogen at 1000 psi, pumped once through a pipe reactor (without benefit of conventional catalysts), then separated into distillable and undistillable fractions. If properly regulated, sufficient hydrogenation occurs to prevent coke formation and substantially more distillate hydrocarbon is produced than in purely thermal coking. There is evidence to indicate that specific hydrocarbon fractions are acting as hydrogen transfer agents or homogeneous catalysts. A marked improvement in conversion and operability can be attained by diluting the feed material with relatively small quantities of low-boiling gas oils. Conversely, any factor which reduces the concentration of low-boiling hydrocarbon species in the pipe reactor (such as topping the feed or using a high gas flow rate) reduces conversion and enhances coking. The results of experiments made with bitumen from the Athabasca Tar Sands deposits are used to illustrate the numerous factors involved in attaining a balance of the conditions required to promote cracking and to minimize the accumulation of pitch deposits in the reaction system.

Ce rapport décrit le travail récent au Centre de recherche sur les combustibles sur le développement d'un procédé d'hydrocraquage pour l'amélioration des huiles lourdes et des goudrons. Des éléments d'hydrogénation et de procédés de craquage thermique ont été combinés dans un système d'écoulement continu pour le traitement préalable du résidu et pour la production des courants distillables plus comptables au raffinage catalytique secondaire d'hydrogène. L'huile est chauffée lentement en présence d'hydrogène à 1000 livres par pouce carré, pompée une seule fois directement dans un réacteur à tuyau (sans l'aide des catalyseurs ordinaires) puis séparée en fractions distillables et non-distillables. Avec un réglage correct, une hydrogénation suffisante se produit pour éviter la formation de coke et on arrive à plus d'hydrocarbure distillé qu'en cokéfaction purement thermique. Il y a des preuves qui indiquent que les fractions spécifiques d'hydrocarbure agissent comme des agents de transfert d'hydrogène ou des catalyseurs homogènes. Il est possible d'atteindre une amélioration remarquable en conversion et en fonctionnement en diluant la substance d'alimentation avec des quantités relativement petites de gaz-huiles à bas degré d'ébullition. Réciproquement, n'importe quel facteur qui réduit la concentration des espèces d'hydrocarbure à bas degré d'ébullition dans un réacteur à tuyau (tel que le fractionnement de l'alimentation ou l'utilisation d'un écoulement rapide de gaz) réduit aussi la conversion et augmente la cokéfaction. Les résultats d'expériences qui ont été faites avec le bitume des gisements des Sables asphaltiques d'Athabasca sont utilisés pour illustrer les facteurs nombreux impliqués pour obtenir un équilibre des conditions nécessaires pour faciliter le craquage et pour réduire au minimum l'accumulation des dépôts de brai dans le système de réaction.

*Technician, ** Section Head, Petroleum and Gas Laboratory and *** Research Scientist, Fuels Research Centre, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

R 247

Exploratory Study on Galvanizing of Iron Single Crystals

G.E. Ruddle* and J.J. Sebisty*

Single crystals of iron with a range of low-index orientations were galvanized in pure zinc in a specially constructed hydrogen atmosphere apparatus.

Significant reaction effects found on (110), (100), and (111) surfaces of commercial single crystals indicated a positive relationship between galvanizing reactivity and crystallographic orientation of the iron substrate surface. The nucleation and growth mode of the predominant ζ iron-zinc alloy layer in the coatings was presumably affected thereby.

Differences in reaction behaviour which remain to be explained were found with the commercial crystals and strain-annealed enamelling-iron crystals of the same orientation.

Normal reaction effects were found on enamelling-iron crystals with other orientations such as (421), (311), (210), and (221).

On a galvanisé dans du zinc pur des monocristaux de fer avec une gamme d'orientation à indices faibles dans un appareil à atmosphère d'hydrogène spécialement construit pour cet essai.

Les effets de réaction significatifs trouvés sur les surfaces des monocristaux commerciaux (110), (100) et (111) ont indiqué une relation positive entre la réactivité de galvanisation et l'orientation cristallographique de la surface du substrat de fer. Ainsi la germination et la façon de croissance de la couche prédominante d'alliage fer-zinc ζ dans les revêtements étaient affectées.

En étudiant les cristaux commerciaux et les cristaux de fer, de même orientation, d'une qualité pour émailler qui sont formés par le procédé de recuit après déformation, les auteurs ont observé des différences de réaction qu'ils ne peuvent encore expliquer.

Les auteurs ont trouvé des effets de réaction normale sur les cristaux de fer d'une qualité pour émailler avec différentes orientations telles que (421), (311), (210) et (221).

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R248

The Role of Gas Bubbles in the Flotation of Quartz

H.P. Dibbs*, L.L. Sirois** and R. Bredin***

A method has been developed to measure the streaming current of gas bubbles in aqueous solutions of inorganic electrolytes and of dodecylamine hydrochloride. The streaming current data obtained in dodecylamine hydrochloride solutions has been compared with the zeta potential and the flotation recovery of quartz for the same solution conditions. The significance, in the flotation recovery of quartz of the relative surface charges on the gas bubbles and on the quartz is discussed.

Les auteurs ont développé une méthode pour mesurer le courant d'écoulement des bulles de gaz dans les solutions aqueuses d'électrolytes inorganiques et de chlorure de dodécylamine. Ils ont comparé les données obtenues, sur le courant d'écoulement des solutions de chlorure de dodécylamine, avec le potentiel zêta et le recouvrement de quartz par flotation pour les conditions de solution. Ils ont discuté de l'importance, dans le recouvrement de quartz par flotation, des charges de surface relatives sur les bulles de gaz et sur le quartz.

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Price 75 cents

Catalogue No. M38-1/248

R249

Evaluation of Lithium Chloride-Diatomaceous Silica Systems for Gas Chromatography of Petroleum Sulphur Compounds

A.E. George*, G.T. Smiley** and H. Sawatzky***

In this study Chromosorb W (diatomaceous silica) as such and also coated with lithium chloride was evaluated as column packing for the gas chromatographic separation of petroleum sulphur compounds. The Chromosorb W by itself was found to be of little value, but quite efficient separations could be obtained after coating with lithium chloride, especially if the chromosorb had been acid washed before coating. Unlike other completely inorganic materials that have been used as column packings, the materials evaluated in this work required temperatures no higher than those required for separations on conventional column packings that contain organic liquids. Inorganic column packings are of great value for the investigation of high-boiling-point materials, like those found in low-grade crude oils, because they are thermally stable.

Dans la présente étude les auteurs ont étudié le Chromosorb W (silice à diatomées) seul, puis recouvert de chlorure de lithium, en qualité de remplissage de colonne pour la chromatographie en phase gazeuse des composés sulfureux du pétrole. Le Chromosorb W tel quel était de très peu d'utilité mais on a pu obtenir des séparations

très efficaces après l'avoir recouvert de chlorure de lithium, surtout après l'avoir lavé à l'acide avant de le recouvrir. Contrairement aux autres matières entièrement inorganiques qui ont servi de remplissages de colonne, les matières évaluées dans le présent rapport n'ont pas nécessité de températures plus élevées que celles qui sont requises pour les séparations dans le cas des remplissages conventionnelles de colonne qui renferment des liquides organiques. Les remplissages inorganiques de colonne sont d'une grande utilité dans l'étude de matières à point d'ébullition élevé telles que celles trouvés dans les pétroles bruts de basse qualité, parce qu'elles sont thermiquement stables.

*National Research Council Postdoctoral Fellow 1969-1971, **Technologist, Fuels Research Centre, ***Research Scientist, Fuels Research Centre, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 75 cents

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R250

Comparison of Dust Sampling Instruments

T.S. Cochrane*, G. Knight**, L.C. Richards***, and W. Stefanich****

This report describes many comparisons between dust sampling instruments. These narrow down to the very wide range in ratio of dust concentrations indicated by any two types of dust sampling instruments in different dust clouds and, therefore, the need to consider physiological factors in applying dust sampling instruments to assess health hazards. Changes in design that are apparently minor can have a large effect on the respirable dust concentration indicated by a sampler that has an aerodynamic size selector.

Dans ce rapport, les auteurs décrivent plusieurs comparaisons entre les instruments pour l'échantillonnage des poussières. Celles-ci se limitent à champ étendu dans le rapport des concentrations de poussière indiquées par deux de n'importe quels genres d'instruments pour l'échantillonnage des poussières dans les différents nuages de poussière et, de là, le besoin de considérer les facteurs physiologiques dans l'application des instruments pour l'échantillonnage des poussières en vue d'évaluer les dangers pour la santé. Les changements de dessin qui sont apparemment mineurs peuvent avoir un grand effet sur les concentrations de poussière respirable indiquées par un échantillonnage qui a un sélecteur de taille aérodynamique.

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Price \$1.25

Catalogue No. M38-1/250

R251

The Determination of the Composition of Slurries by the Measurement of Thermal-Neutron-Capture Gamma Radiation

H.P. Dibbs*, J.L. Dalton**, and S.S. Nargolwalla***

A study has been made of the application of thermal-neutron-capture gamma radiation to the determination of the composition of aqueous slurries of iron oxide, cupric oxide, zinc oxide sulphur, and silica. In general, a linear relationship was found between the solids content of the slurry and the prompt-gamma-ray counts from hydrogen and from the solid phase, and an equation is presented that predicts the variation of the prompt-gamma-ray counts from hydrogen with the composition of the slurry.

Les auteurs ont fait une étude de l'application du rayonnement gamma pour la capture de neutrons thermiques pour déterminer la composition des coulis aqueux d'oxyde de fer, d'oxyde cuivrique, d'oxyde de zinc, de soufre et de silice. En général, ils ont trouvé qu'il y avait une relation linéaire entre la teneur en solides du coulis et les comptes de rayons gamma instantanés de l'hydrogène et de la phase solide, et les auteurs présentent une équation qui prédit la variation des comptes de rayons gamma instantanés de l'hydrogène avec la composition du coulis.

*Head, Surface Sciences Group, ** Spectrochemist, Spectrochemistry Group, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada; and *** Head, Neutron Activation Laboratory, Scintrex Limited, Concord, Ontario, Canada.

Price 75 cents

Catalogue No. M38-1/251

R252

Recovery of Bismuth from HCl Leach Solutions by Cementation on Iron

D.J. Mackinnon*

The feasibility of recovering metallic bismuth from strong hydrochloric acid leach liquors by cementation on iron has been investigated. Several types of iron were used to cement bismuth from solutions containing up to 4.0 g Bi/l. Zinc and lead powders were ineffective as cementing agents for bismuth from actual leach liquors. The reaction on iron, however, which produced a loose deposit of bismuth, was extremely rapid at room temperature. The effect of Cu^{++} , Zn^{++} , Fe^{++} and Fe^{+++} , which were present in the leach liquor, on the reaction rate, stoichiometry and purity of product was also determined. Of these, only Fe^{+++} had an appreciable effect, causing a decrease in the reaction rate and an increase in the consumption of iron. Other variables that had a significant effect on the reaction were temperature, surface area of iron, and the type of iron used.

L'auteur a étudié la possibilité de récupérer du bismuth métallique des liqueurs fortes de lessive d'acide chlorhydrique par la cémentation sur fer. Il a utilisé plusieurs types de fer pour cimenter le bismuth des solutions contenant jusqu'à 4.0 g Bi/l. Les poudres de zinc et de plomb étaient inefficaces comme agents de cémentation pour le bismuth des liqueurs réelles de lessive. Cependant, la réaction

sur fer qui a produit un dépôt meuble de bismuth, était extrêmement rapide à la température ambiante. Il a aussi déterminé l'effet du Cu^{++} , de Zn^{++} , de Fe^{++} et de Fe^{+++} , qui étaient présents dans la liqueur de lessive, sur la vitesse de réaction, la stoechiométrie et la pureté du produit. De ceux-ci, seulement le Fe^{+++} avait un effet appréciable ayant comme résultat une diminution de la vitesse de réaction et une augmentation de la consommation du fer. D'autres variables ayant un effet significatif sur la réaction étaient la température, la surface du fer et le type de fer utilisé.

*Research Scientist, Research Section, Extraction Metallurgy Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada. K1A 0G1.

Price 50 cents

Catalogue No. M38-1/252

R253 The Hydrocracking of Residual Oils and Tars Part 2: The Catalytic Hydrocracking of Athabasca Bitumen

E.C. McColgan* and B.I. Parsons**

The report describes a bench-scale investigation of the catalytic hydrocracking of the $+975^{\circ}\text{F}$ residuum in Athabasca bitumen with a view to a) increasing the yield of liquid hydrocarbon obtained compared with coking or purely thermal hydrocracking methods, and b) reducing the extent of on-site treatment required to produce relatively clean, stable distillates suitable for transmission to more central areas. The experiments were made in the liquid phase, using a conventional flow apparatus with a bottom-feed reactor and a commercially available cobalt molybdate catalyst. The range of pressures investigated was 1000 to 2500 psi at space velocities of 1.05 and 2.1. Comparing the yields of liquid product obtained by catalytic methods with those obtained by purely thermal hydrocracking, the permissible catalyst cost is estimated at 50 - 55¢ per barrel of feed.

Ce rapport décrit une recherche faite au laboratoire sur l'hydrocraquage catalytique du $+975^{\circ}\text{F}$ résidu dans le bitume d'Athabasca dans le but de a) augmenter le rendement du liquide d'hydrocarbure obtenu par la cokéfaction ou par les méthodes d'hydrocraquage purement thermique, et b) réduire le degré de traitement nécessaire pour produire des distillats relativement propres et stables convenables pour la transmission aux endroits plus centraux. Ils ont fait des expériences à la phase liquide utilisant un appareil d'écoulement ordinaire avec un réacteur d'alimentation par le bas et un catalyseur disponible commercialement au cobalt et au molybdène. La gamme des pressions étudiées a été de 1000 à 2500 psi aux vitesses spatiales de 1.05 et 2.1. En comparant les rendements du produit liquide obtenu par les méthodes catalytiques à ceux obtenus par l'hydrocraquage purement thermique, ils ont trouvé que le coût du catalyseur permissible est estimé à 50 - 55¢ par baril d'alimentation.

*Technician and **Research Scientist, Fuels Research Centre, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

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TECHNICAL BULLETINS

TB142

Coal Washery Design-II, The Computation of Recirculating Loads

Jacqueline L. Picard*

This bulletin, Part II of a series, deals with the EMR¹⁾ process for the beneficiation of coal. Several considerations have contributed to its publication. Firstly, one of the elements of process design is that two-stage operation, with recirculation of intermediate products properly applied, may enhance the separation efficiency and the financial returns of a processing plant. Secondly, the prevention of pollution at the source enforces effective control of water clarification and slimes removal. For these reasons alone, closed-circuit operation of processing plants deservedly receives more attention to-day than it has in the past.

Effective control of slimes and recirculating middlings requires detailed information on the separating efficiency of the equipment units and involves the calculation of individual solids' flowrates under steady-state conditions. The processing of this data poses a problem in that the volume of work, if done manually or on a calculator, requires too much time.

Detailed instructions are given for calculating closed circuit flow diagrams, using a small digital computer. Derivations of circuit equations are presented in an appendix. A "decision flowchart", applicable to any combination of separators (to a maximum of five units), is presented for calculating the "recirculation coefficient" λ of individual size-fractions and gravity-fractions of the raw feed as it passes through the plant. Applications of the method of calculation are illustrated for a number of unit combinations encountered in coal washeries.

Ce bulletin, la deuxième partie d'une série, traite d'un procédé du ministère de l'Energie, des Mines et des Ressources pour l'enrichissement du charbon. Plusieurs considérations ont favorisé sa publication. D'abord, un des éléments du calcul fondamental d'une installation est que si l'opération à deux étages avec la recirculation des produits intermédiaires est utilisée correctement, l'efficacité de séparation et les profits d'une installation de traitement pourront augmenter. Ensuite, l'empêchement de pollution à la source assure un contrôle efficace pour la purification de l'eau et pour l'enlèvement des boues. Pour ces seules raisons, on doit porter plus d'attention aujourd'hui qu'auparavant à l'opération en circuit fermé des installations de traitement.

Le contrôle efficace des boues et de la recirculation des mixtes nécessite les renseignements détaillés sur l'efficacité de séparation des unités de l'équipement et implique le calcul des "débits particuliers des solides" sous régime stable. Le traitement de ces données pose un problème de sorte que si le volume de travail se fait manuellement ou par une machine à calculer, il nécessite trop de temps.

On donne des instructions détaillées pour le calcul en circuit fermé des schémas de fonctionnement, en utilisant un calculateur numérique. Les dérivations des équations de circuit se trouvent à l'appendice. On présente un "diagramme déterminant de débits", applicable à n'importe quelle combinaison de séparateurs (à un maximum de cinq unités) pour le calcul du "coefficient de recirculation" des fractions particulières de taille et de gravité de l'alimentation brute pendant qu'elle parcourt l'installation.

On illustre l'application de la méthode de calcul pour un nombre de combinaisons d'unités rencontré dans les lavoirs de charbon.

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1) Abbreviation for: Energy, Mines and Resources.

Price 75 cents

Catalogue No. M34-20/142

TB143 Colorimetric Analysis Programs for the PDP-10 Time Sharing System

D. Fraser* and R.F. Pilgrim**

Three computer programs have been developed for a PDP-10 time sharing system to process the output data obtained at regular time intervals from a continuous colorimetric analyzer. The programs maintain a library of calibration curves, compute the concentrations of reacting species and, by means of selected plots and regressions, yield chemical rate constants. A unique feature of the programs permits the use of unformatted data input.

The report is produced in two parts:

Part 1 - User's Manual - This describes the purpose of the three programs and the entry of data;

Part 2 - Programmer's Manual - this describes the structure of the programs and the related files; a tested method for loading, compiling, and executing the programs is given.

On a développé trois programmes pour le système de l'ordinateur PDP-10 pour traiter l'information obtenue à intervalles de temps régulier d'un analyseur colorimétrique en continu. Les programmes maintiennent une bibliothèque des courbes d'étalonnage, calculent les concentrations des espèces réactives et par moyen des tracés et des rebroussements choisis produisent les taux de constantes chimiques. Une unique particularité des programmes permet l'utilisation de l'information non-éditée.

Le rapport se devise en deux parties:

1^{ère} Partie - Manuel de l' Usage - description du but des trois programmes et l'introduction des données.

2^e Partie - Manuel du Programmeur - description de la structure des fichiers relatifs; on présente une méthode vérifiée pour le chargement, la compilation et l'exécution des programmes.

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TB144

Canadian Observations on the Proposed ISO/TC 102/SC 3 Method for Measuring the Relative Reducibility of Natural and Processed Iron Ores

D.A. Reeve* and J.H. Walsh**

This technical bulletin presents results of a series of tests done to evaluate some of the parameters of the proposed ISO/TC 102/SC 3 (International Organization for Standardization, Technical Committee 102 - Iron Ores, Sub-Committee 3 - Physical Testing of Iron Ores) method for measuring the relative reducibility of natural and processed iron ores, and to make recommendations for possible consideration in drafting the next ISO proposal.

The present report (with the exception of Figure 1) was tabled at the first working group meeting of ISO/TC 102/SC 3 held in Dusseldorf, West Germany, October 4th - 7th, 1971 and was given the ISO Document Number (Canada-3) 187E.

On présente dans ce bulletin technique les résultats d'une série d'essais faits pour évaluer quelques-uns des paramètres d'une méthode proposée par la ISO/TC 102/SC 3 (Organisation internationale de normalisation, Comité technique 102 - Minerais de fer, Sous-comité 3 - Essai physique des minerais de fer) pour mesurer la réductibilité relative des minerais de fer naturels et traités et pour présenter des recommandations pour une considération possible faite par écrit de la prochaine proposition de la ISO.

Le rapport actuel (à l'exception de figure 1) a été présenté à la première réunion du groupe de travail de la ISO/TC 102/SC 3 à Dusseldorf, Allemagne de l'Ouest, du 4 au 7 octobre 1971, et porte le numéro de document (Canada - 3) 187-E de la ISO.

*Assistant to Group Leader, Metallurgical Fuel Engineering Group, Metals Reduction and Energy Centre, and ** Manager, Metals Reduction and Energy Centre, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Ontario.

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TB145

Tentative Design Guide for Mine Waste Embankments in Canada

D.F. Coates*

The prime function of both mine waste piles and mine tailings ponds is to store solids. However, tailings ponds usually must provide temporary storage of a certain minimum volume of water for clarification prior to reclaim for plant use or discharge to adjacent streams. Where tailings pond effluent would be a serious pollutant, tailing embankments may have to be designed to retain as much water as practicable, reliance being placed on water reclaim and evaporation to prevent its release to surface or sub-surface water courses. If this is not practicable, it may be necessary to treat the water prior to its release from the pond.

Two extreme approaches are therefore possible in the design of mine tailings embankments - to make the embankment relatively impervious, or to make it relatively pervious. Whether one of these or an intermediate approach is taken, the embankment must be adequately stable and necessary provisions must be made to control seepage through and under the embankment and to control surface run-off into the pond.

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Catalogue No. M34-20/145

TB146 Mineralogical Investigation of Some Base Metal Ore Deposits and Occurrences in the Red Lake Mining Division, Ontario.

D.C. Harris*

Three main types of base-metal sulphide mineralization are present in the Red Lake Mining Division:

- (1) small massive copper-lead-zinc deposits occurring mainly in drag folds or shear zones in sequences of metavolcanic and metasedimentary rocks, sometimes intruded by gabbroic sills and invariably surrounded by granitic rocks; most of these deposits are located in the belt of volcanic rocks in the Confederation Lake area, 50 miles east of Red Lake, and are typified by the Fredart Lake and South Bay Mines deposits. In the Red Lake area, this type of deposit is represented by the Trout Bay sulphide prospect located on the western limb of the Red Lake basin-like volcanic complex;
- (2) low-grade disseminated nickel and copper mineralization as shown by the Trout Bay nickel prospect; the mineralization occurs in an antigorite-tremolite schist occurring along the stratigraphic top of a chert-magnetite iron formation; the schist represents the sheared and altered basal portion of a metagabbro sill;
- (3) massive to disseminated occurrences of galena in carbonate zones cut by numerous quartz stringers and veins; these shear zones are associated with metavolcanic rocks that have been intruded by quartz porphyry; the Galena Island and Middle Bay prospects are typical of this mode of mineralization.

Dans la Division minière de "Red Lake", on trouve trois sortes de la minéralisation de metal commun sulfuré:

- (1) les petits gisements massifs de cuivre-plomb-zinc qui se trouvent surtout dans les plis d'étirement ou dans les zones de cisaillement en série de roches volcaniques et sédimentaires partiellement métamorphosées et quelques fois introduites par les seuils gabbroïques et toujours entourés de roches granitiques; on peut trouver ces gisements dans la zone de roches volcaniques dans la région de "Confederation Lake", 50 miles à l'est de "Red Lake" et ils sont caractéristiques des gisements des mines de "Fredart Lake" et "South Bay"; dans la région de "Red Lake", cette sorte de gisements est représentée par la zone d'intérêt pour le sulfure de "Trout Bay" située dans la partie ouest du complexe volcanique genre bassin de "Red Lake";
- (2) la minéralisation de nickel et de cuivre disséminés à faible teneur telle qu'indiquée par la zone d'intérêt pour le nickel de "Trout Bay"; la minéralisation se présente dans un schiste d'antigorite-tremolite se trouvant le long de la limite stratigraphique supérieure d'une formation de fer de chert-magnétite; le schiste représente la base cisailée et modifiée d'un seuil de métagabbro;
- (3) l'occurrence de galène soit sous forme massive soit sous forme disséminée dans les zones de carbonate coupée par de nombreuses ficelles et veines de quartz; ces zones de cisaillement sont associées aux roches volcaniques partiellement métamorphosées où le porphyre quartzifère s'est introduit; les zones d'intérêt de l'Île Galène et de "Middle Bay" sont typiques de ce mode de minéralisation.

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TB147

The Determination of Slurry Density by Fast-Neutron Thermalization

H.P. Dibbs*, J.L. Dalton** and C. McMahon***

An account is given of the application of the neutron-moisture gauge principle to the determination of the density of iron oxide slurries. A linear relationship was found between the solid:liquid ratio of the water slurry, from 15 to 50 per cent by weight, and the neutron count-rate. These results are compared with simultaneous density measurements made with a gamma-density gauge. The influence on the density measurements of elements with large neutron cross sections is also discussed.

Les auteurs présentent un compte rendu de l'application du principe de jauge de neutron et d'humidité pour la détermination de la densité des coulils d'oxyde de fer. Ils ont trouvé un rapport linéaire entre le rapport solide: liquide du coulil d'eau, de 15 à 50 pourcent de pesanteur, et le taux de comptage de neutrons. Ils ont comparé les résultats aux mesures de densité faites simultanément avec une jauge de densité de gamma. Ils discutent aussi de l'influence sur les mesures de densité des éléments avec de larges sections efficaces de neutrons.

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TB 148

Northern Mining Problems with Particular Reference to Unit Operations in Permafrost

Amil Dubnie*

As transportation facilities improve, the economics of northern mining will be favourably affected and substantially more mines will be operated. Many of the mines may be located in permafrost, but, so far, few Canadian studies of mining within such an environment have been made.

Surface miners have already learned how to operate in the North, and, through trial and error, modifications to equipment and to the conditions for personnel have enabled year-round operation. However, efficient fragmenting of frozen rock may be one area where methodical research may reduce the costs of northern operations.

Underground miners have applied southern methods to northern mining with only minor modifications. This may have led to higher mining costs than necessary, but, owing to other major problems (i.e., transportation), they may have been obscured. The possibility of developing new concepts for northern mining, whereby the environment would be preserved to utilize whatever advantages it may present, has not received attention.

This report discusses research in many areas of northern mining such as: the evaluation of supports in access openings and stopes in permafrost; the use of frozen fills as support; the environmental effects of dry mining; the techniques of ice control in access openings.

Lorsque les facilités de transport s'amélioreront, la politique économique de l'industrie minière dans le Nord sera mieux disposée, et donc, plus de

mines seront installées d'une manière substantielle. Plusieurs des mines sont situées dans le pergélisol, mais, jusqu'à date, il y a eu peu d'études minières faites par des Canadiens dans un tel milieu.

Les mineurs de l'exploitation à ciel ouvert ont déjà appris comment s'installer dans le Nord, et c'est à force de procéder par tâtonnements pour modifier l'équipement et améliorer les conditions de vie pour le personnel, que l'entreprise peut être en vigueur durant toute l'année. Cependant, un domaine dans lequel une recherche méthodique pourrait réduire le coût de l'industrie minière dans le Nord, est celui de la fragmentation efficace des roches gelées.

Les mineurs souterrains ont fait l'application des méthodes du Sud avec des modifications mineures pour l'industrie minière dans le Nord. Ceci peut avoir causé une hausse dans le coût de l'installation, mais à cause d'un certain nombre de problèmes majeurs (tels que la transportation), il a dû être effacé. Il n'y a pas eu d'importance jetée sur la possibilité de développer de nouveaux concepts pour l'industrie minière dans le Nord, où le milieu pourrait être préservé et où on pourrait utiliser quelques soient ses avantages.

Ce rapport traite de la recherche dans plusieurs domaines de l'industrie minière dans le Nord, tels que: l'évaluation de soutènements pour accès à la mine et pour chantiers dans le pergélisol; l'usage de matériaux de remblai gelés comme soutènement; les effets écologiques de l'exploitation à sec; les techniques du contrôle de la glace pour les accès à la mine.

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TB148F

Problèmes miniers dans le nord avec référence particulière aux chantiers d'exploitation dans le pergélisol

Amil Dubnie*

A mesure que les moyens de transport s'amélioreront, l'économique de l'exploitation minière nordique sera favorablement affectée et substantiellement plus de mines seront mises en exploitation. Plusieurs des mines pourront être localisées dans le pergélisol, mais, jusqu'ici, peu d'études canadiennes ont été faites sur l'exploitation minière dans cet environnement.

Les mineurs de surface ont déjà appris comment faire l'exploitation dans le Nord, et à travers des essais successifs, des modifications à l'équipement et aux conditions du personnel ont permis l'exploitation tout au long de l'année. Toutefois, la fragmentation efficace de la roche gelée peut être un domaine où la recherche méthodique peut réduire le coût de l'exploitation en zone nordique.

Les mineurs souterrains ont appliqué les méthodes du Sud à l'exploitation minière en zone nordique avec seulement des modifications mineures. Ceci peut mener à des coûts d'exploitation plus élevés que nécessaire, mais étant donné d'autres problèmes majeurs (i.e. le transport) ils ont pu être obscurcis. La possibilité de développer de nouvelles méthodes pour l'exploitation minière en zone nordique par lesquelles l'environnement serait préservé pour utiliser quelques avantages que celui-ci présente, n'a pas reçu d'attention.

Ce rapport discute de la recherche dans plusieurs domaines de l'exploitation minière en zone nordique comme l'évaluation du soutènement dans les

ouvertures accessibles et dans les chantiers d'abattage situés dans le pergélisol; l'usage de remblais gelés comme soutènement; les effets sur l'environnement minier de faire le minage à sec; les techniques de contrôle de la glace dans les ouvertures d'accès.

As transportation facilities improve, the economics of northern mining will be favourably affected and substantially more mines will be operated. Many of the mines may be located in permafrost, but, so far, few Canadian studies of mining within such an environment have been made.

Surface miners have already learned how to operate in the North, and, through trial and error, modifications to equipment and to the conditions for personnel have enabled year-round operation. However, efficient fragmenting of frozen rock may be one area where methodical research may reduce the costs to northern operations.

Underground miners have applied southern methods to northern mining with only minor modifications. This may have led to higher mining costs than necessary, but, owing to other major problems (i.e. transportation), they may have been obscured. The possibility of developing new concepts for northern mining, whereby the environment would be preserved to utilize whatever advantage it may present, has not received attention.

This report discusses research in many areas of northern mining such as: the evaluation of supports in access openings and stopes in permafrost; the use of frozen fills as support; the environmental effects of dry mining; the techniques of ice control in access openings.

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No de catalogue M34-20/148F

TB 149

The Use of Flame Procedures for the Analysis of Minerals, Ores, and Electric Furnace Slags Part 1: Sample Dissolution and Atomic Absorption Procedures for Use in the Determination of Silicon - A Review

R.J. Guest*

As the first report in a series on atomic absorption procedures for silicon, a literature review is presented with the intention of applying this information to the development of a general silicon procedure for use on a wide variety of sample material. In particular, the desired procedure should be applicable to most common types of ore as well as to electric furnace slags and associated materials. Several dissolution procedures are discussed as well as the effect on the procedure of such variables as interfering ions, sample matrices, solution stability, and some instrumental parameters.

Comme premier d'une série de rapports sur les méthodes de spectroscopie d'absorption utilisées pour le dosage de la silice, l'auteur présente une revue de la documentation existante afin d'utiliser ces renseignements pour le développement d'une méthode générale de dosage de la silice qui pourrait être utilisée pour une grande variété de substances. La méthode recherchée devrait s'appliquer plus particulièrement aux minerais des types les plus communs ainsi qu'aux scories des fours électriques et aux matériaux associés. L'auteur traite de plusieurs méthodes de dissolution ainsi que de l'effet sur ces méthodes de variables telles l'interférence d'ions, les matrices des échantillons, la stabilité des solutions ainsi que certains paramètres propres au matériel utilisé.

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Price 50 cents

Catalogue No. M34-20/149

TB150 The Use of Flame Procedures for the Analysis of Minerals, Ores, and
Electric Furnace Slags Part II: Determination of Silicon in
Sulphide and Silicate Minerals and Their Mixtures

R.J. Guest* and D.R. MacPherson**

This report, the second in a series of three, describes methods for the determination of silicon in typical sulphide and silicate minerals by atomic absorption spectrophotometry, using either hydrofluoric acid attack under pressure in a Teflon bomb or sodium peroxide fusion with subsequent controlled acidification. Both decomposition methods give silicon solutions which have excellent long-term stability and which are also suitable for the determination of other elements in the sample. The effects of various common contaminants carried through the whole procedure are described, and though, in general, satisfactory results are obtainable using pure silicon solutions as comparison standards, it is shown that the addition of an equivalent amount of the major contaminant present in the sample can give a significant gain in accuracy. The method is applicable to synthetic solutions and to specimen-grade minerals, separately and in mixtures, that represent most Canadian ores. Many types of sample materials, covering a range of silicon content from 0.1 to 45%, can be analysed with a considerable saving in time over gravimetric procedures. The average coefficient of variation found was 1.4%. Much of the deviation (of some 5%) from the gravimetric results can be attributed to the inaccuracies of that method.

Dans ce rapport qui est le deuxième dans une série de trois, les auteurs décrivent les méthodes pour la détermination du silicium dans les minéraux sulfurés et siliceux typiques par la spectrophotométrie d'absorption atomique, utilisant soit l'acide fluorhydrique attaqué sous la pression dans une bombe Téflon soit la fusion du peroxyde de sodium avec l'acidification subséquente et contrôlée. Les deux méthodes de décomposition donnent des solutions de silicium qui ont une stabilité excellente de longue durée et qui sont aussi convenables pour la détermination d'autres éléments de l'échantillon. Les auteurs décrivent les effets d'impuretés communes et variées qui se trouvent à travers le procédé complet, et quoique en général les auteurs aient obtenu des résultats satisfaisants utilisant des solutions pures de silicium comme norme de comparaison, il est montré que l'addition d'un montant équivalent d'impureté majeure présente dans l'échantillon peut produire une amélioration significative dans la précision. La méthode est applicable aux solutions synthétiques et aux minéraux de grade-spécimen, séparément et dans les mélanges, qui représentent la plupart des minerais canadiens. Plusieurs genres de matériaux à échantillon, couvrant une gamme de teneur de silicium de 0.1 à 45% peuvent être analysés en gagnant beaucoup de temps avec les procédés gravimétriques. Le coefficient de variation était de 1.4%. Beaucoup de déviations (quelques-unes de 5%) des résultats gravimétriques peuvent être attribuées aux imprécisions de cette méthode.

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Price 75 Cents

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TB151 The Use of Flame Procedures for the Analysis of Minerals, Ores,
and Electric Furnace Slags Part III: Determination of Silicon in
Electric Furnace Slags

R.J. Guest* and D.R. MacPherson**

Rapid procedures, suitable for control and many other purposes, are described for the determination of silicon in electric furnace slags and associated materials and in ores and their mixtures. After sample dissolution by hydrofluoric acid in a Teflon bomb or after a sodium peroxide fusion and subsequent acidification, silicon is determined by an atomic absorption procedure. Other elements may be determined on the same solution as the silicon because no chemical separations have been made. Atomic absorption and chemical results are compared, and the precision found for the atomic absorption procedures is shown. The effectiveness of two atomizer-burner systems is compared, and it is shown to be necessary, in one of these systems, to add a major contaminant to the comparison standard in order to obtain suitable accuracy.

Les auteurs décrivent les procédés rapides, qui sont convenables pour le contrôle et pour plusieurs autres buts, pour la détermination du silicium dans les scories provenant du four électrique et les minéraux associés et dans les minerais et leurs mélanges. Après la dissolution de l'échantillon par l'acide fluorhydrique dans une bombe Téflon ou après la fusion du peroxyde de sodium et l'acidification subséquente, le silicium est déterminé par un procédé d'absorption atomique. D'autres éléments peuvent être déterminés dans la même solution comme le silicium parce qu'il n'y a pas eu de séparations chimiques. Les auteurs ont comparé l'absorption atomique et les résultats chimiques, et la précision trouvée pour les procédés d'absorption atomique est démontrée. Ils ont comparé l'efficacité de deux systèmes de brûleur-atomiseur et il paraît nécessaire d'ajouter à un de ces systèmes une impureté majeure à la norme de comparaison afin d'obtenir une précision convenable.

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Catalogue No. M34-20/151

TB 152 The Polarographic Determination of Titanium; Application to the
Analysis of Lead Zirconate - Lead Titanate Electronic Ceramics

A. Hitchen*

A polarographic method for the determination of titanium using a 0.5 M ammonium acetate + 0.1 M acetic acid + 0.1 M disodium ethylenediaminetetraacetate (EDTA) supporting electrolyte is described. The titanium polarographic wave is well-defined in this medium. Relatively few elements interfere, and procedures are suggested to overcome some of those that do.

The method has been used to determine titanium in lead zirconate-lead titanate ceramic powders and solutions. The results compare favourably with results obtained by a differential spectrophotometric method.

L'auteur décrit une méthode polarographique de dosage du titane à l'aide d'un électrolyte indifférent comprenant 0.5 M d'acétate d'ammonium, 0.1 M d'acide acétique et 0.1 M de tétraacétate d'éthylènediamine et de sodium. Le polarogramme du titane est très bien défini dans ce milieu. Il y a relativement peu d'éléments qui créent de l'interférence et l'auteur propose certaines méthodes pour contrer les effets de quelques éléments de ce genre.

La méthode a été utilisée pour doser le titane dans des poudres et des solutions de céramiques à base de zirconate de plomb et de titanate de plomb. Les résultats obtenus se comparent favorablement à ceux qu'on obtient en utilisant une méthode de spectrophotométrie différentielle.

*Senior Scientific Officer, Chemical Analysis Section, Extraction Metallurgy Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 75 cents

Catalogue No. M34-20/152

TB 153

The Determination of Titanium in Lead Zirconate-Lead Titanate Electronic Ceramics. A Comparison of Titrimetric Methods with Polarographic and Differential Spectrophotometric Methods

A. Hitchen*

Three procedures for the determination of titanium in lead zirconate-lead titanate powders and process solutions which are simple, rapid, precise, and accurate are described. Two of the methods are based on reduction of the titanium with a) liquid zinc or lead amalgams or b) metallic aluminum, followed by titration of the reduced titanium with a standard ferric sulphate solution using sodium thiocyanate as the indicator. The third method is a polarographic procedure using an acetate + EDTA electrolyte. Relatively few elements interfere and procedures are suggested to overcome some of those that do. The accuracy and precision of the methods compare favourably with the much longer differential spectrophotometric method.

L'auteur décrit trois méthodes simples, rapides et précises pour la détermination du titane dans les poudres composées du zirconate de plomb et du titanate de plomb et dans les solutions. Les deux méthodes sont basées sur la réduction du titane avec a) du zinc liquide ou des amalgames de plomb ou b) de l'aluminium métallique suivi par le tirage du titane réduit avec une solution titrée de sulfate ferrique utilisant du thiocyanate de sodium comme indicateur. La troisième méthode est un procédé polarographique utilisant un acétate + une électrolyte EDTA. Relativement peu d'éléments interfèrent et l'auteur suggère des procédés pour surmonter ceux qui interfèrent. La précision des méthodes se compare favorablement à celles de la méthode beaucoup plus longue de spectrophotométrie différentielle.

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Catalogue No. M34-20/153

TB154

Measurement of the Reactivity of Carbons for Metallurgical Processes
Part I - Theoretical Considerations

D.A. Reeve*

Part II - Reactivity of Crushed Coke

D.A. Reeve*, N.J. Ramey** and K.H. Hampel***

In Part I of this report, the importance of the reactivity of carbons to such metallurgical processes as the blast furnace and the SL/RN Direct Reduction Process is examined and the chemistry of the Boudouard Reaction is discussed.

In Part II, three test methods for measuring the reactivity of cokes to carbon dioxide are compared, a loss-in-weight method, a gas-analysis method with constant CO₂ flow rate, and a gas-analysis method with a variable CO₂ flow rate but constant amount of conversion of CO₂ to CO. Test results from the three methods on a series of eight cokes made from North American coking coals showed that any of the three methods would give acceptable relative reactivity values. A correlation between coke reactivity and blast furnace performance does not appear to have been established.

Dans la 1^{ère} Partie de ce rapport, l'auteur examine l'importance de la réactivité des carbones dans les procédés métallurgiques tels que le haut fourneau et le Procédé SL/RN de Réduction Directe. De plus, on discute de la chimie de la Réaction Boudouard.

Dans la 2^e Partie, les auteurs comparent trois méthodes d'essai pour mesurer la réactivité des cokes au gaz carbonique: une méthode de chute de poids, une méthode d'analyse de gaz avec un débit constant de CO₂, et une méthode d'analyse de gaz avec un débit variable de CO₂ mais une quantité constante de conversion de CO₂ à CO. Les résultats d'essai des trois méthodes sur une série de huit cokes faits des charbons cokéfiants du Nord Amérique ont montré que n'importe lesquelles des trois méthodes donneraient des valeurs de réactivité relativement acceptables. Une corrélation entre la réactivité du coke et la performance du haut fourneau ne paraît pas avoir été établie.

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TB155

Zinc-Tin-Copper-Lead Ore, MP-1: Its Characterization and Preparation
for Use as a Standard Reference Material

G.H. Faye*

The Mines Branch of the Department of Energy, Mines and Resources has undertaken a program to prepare a number of ores of metallic minerals for use as standard reference materials. This report describes the characterization and preparation of the second ore in the program, a zinc-tin-copper-lead ore, MP-1, from New Brunswick.

The mineralogical, geological, and chemical characteristics of MP-1

are given as well as some details of methods used for its comminution, blending, and for assessing its homogeneity. Nineteen laboratories participated in the program by providing analyses for selected elements. The recommended mean values for these are: Zn-16.33%; Sn-2.50%; Cu-2.15%; Pb-1.93% Mo-0.014%: In - 0.071%; Bi-0.25%; As-0.79%; Ag-59.5ppm. The analytical results and the evaluation of statistical parameters for the above elements are reported.

La Direction des mines du ministère de l'Energie, des Mines et des Ressources a entrepris un programme pour un nombre de minerais de minéraux métalliques utilisés comme matériaux types de référence. Ce rapport décrit la caractérisation et la préparation du second minerai dans le programme, un minerai de zinc-étain-cuivre-plomb, MP-1, du Nouveau Brunswick.

Les caractéristiques minéralogiques, géologiques et chimiques du MP-1 sont données ainsi que quelques détails des méthodes utilisées pour sa pulvérisation, son mélange et pour l'évaluation de sa homogénéité. Dix-neuf laboratoires ont participé dans le programme en fournissant les analyses pour les éléments choisis. La moyenne recommandée pour ceux-là sont: Zn-16.33%; Sn-2.50%; Cu-2.15%; Pb-1.93%; Mo-0.014%: In-0.071%; Bi-0.25%; As-0.79%; Ag-59.5 ppm. Les résultats analytiques et l'évaluation des paramètres statistiques pour les éléments ci-dessus sont donnés.

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TB156

The Determination of the Zeta Potential of Minerals

H.P. Dibbs*

An improved streaming-potential method is described for the determination of the zeta potential of minerals and its application to some oxide and sulphide minerals is discussed.

L'auteur décrit une méthode améliorée de potentiel d'écoulement pour la détermination du potentiel zêta des minéraux et de plus il discute l'application de cette méthode pour quelques minéraux sulfurés et oxydés.

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Price 75 cents

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TB160

The Construction and Operation of a Meter for Measuring the Quality of Zinc Electrolytes

R.C. Kerby*, J.M. Branne**, and T.R. Ingraham***

The construction and operation of a meter for automatically measuring the quality of zinc electrolytes, in relation to zinc electrodeposition, is described. The meter consists essentially of a small zinc electrolysis cell and a gas detection unit for

measuring the hydrogen evolved during electrolysis. The amount of hydrogen evolved provides a measure of current efficiency during zinc electrolysis. The meter can be used to provide a continuous record of the quality of the zinc electrolyte which is used in the cell room of a zinc electrolytic plant.

Les auteurs décrivent la construction et le fonctionnement d'un compteur pour mesurer automatiquement la qualité des électrolytes de zinc, en relation avec l'électrodéposition de zinc. Le compteur se compose essentiellement d'une petite pile d'électrolyse de zinc et d'une unité pour la détection de gaz pour mesurer l'hydrogène dégagé pendant l'électrolyse. Le montant d'hydrogène dégagé fournit une mesure d'efficacité du courant pendant l'électrolyse de zinc. Le compteur peut être utilisé pour fournir un rapport continu sur la qualité de l'électrolyte de zinc qui est utilisé dans une pile d'une installation d'électrolyte de zinc.

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TB161 A Comparison of Bottom-Feed and Top-Feed Reaction Systems for Hydrodesulphurization

T. Takematsu* and B.I. Parsons**

The bulletin describes a bench-scale investigation of top-feed (mixed-phase) and bottom-feed (liquid-phase) continuous-flow systems for the hydrodesulphurization of a heavy "coker" gas-oil derived from the Athabasca bitumen. The specific gravity of the feed stock was 0.95 and the sulphur content was 3.4 wt%. The catalyst used was a commercially prepared mixture of the oxides of cobalt and molybdenum on alumina. In almost every respect the bottom-feed system was found to be more effective than the top-feed arrangement. The greater heat transferring capability of the liquid phase and the mixing effected by the bubbling hydrogen improved temperature control within the reactor considerably. More extensive desulphurization (at higher space velocities) was possible with the bottom-feed arrangement because of the longer residence time and improved temperature control. Fuel oil containing 1% sulphur could be produced at a space velocity of 3, 355°C, and 2000 psi with only 3 to 4 % hydrocracking to low-boiling fractions. Fuel oil containing only 0.5% sulphur could be produced at similar temperatures and pressures at a space velocity of 2.

Ce bulletin décrit une recherche faite au laboratoire sur les systèmes à écoulement continu d'alimentation par le haut (phase mixte) et d'alimentation par le bas (phase liquide) pour la hydrodesulfuration d'un gas-oil lourd dérivé du bitume d'Athabasca.

La gravité spécifique de la charge d'alimentation était de 0.95 et la teneur en soufre était de 3.4 wt%. Ils ont utilisé un catalyseur qui était un mélange préparé commercialement des oxydes de cobalt et de molybdène sur l'alumine. Ils ont trouvé presque dans tous les cas que le système d'alimentation par le bas était plus

efficace que la disposition d'alimentation par le haut. Ils ont aussi remarqué que la plus grande capacité de transfert de chaleur de la phase liquide et du mélange effectuée par le bouillonnement d'hydrogène a considérablement amélioré le contrôle de la température à l'intérieur du réacteur. Une plus grande désulfuration (à de hautes vitesses spatiales) a été possible par un séjour plus long dans un réacteur et par un contrôle amélioré de température avec une disposition d'alimentation par le bas. L'huile combustible contenant 1% de soufre pourrait être produite à une vitesse spatiale de 3, 355°C, et 2000 psi avec seulement 3 à 4% d'hydrocraquage aux fractions à bas point d'ébullition. L'huile combustible qui contient seulement 0.5% de soufre pourrait être produite aux températures et pressions semblables à une vitesse spatiale de 2.

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INFORMATION CIRCULARS

IC237 Solution Purification by Ion Exchange or Solvent Extraction

G.M. Ritcey*

The subject of solution purification using ion exchange or solvent extraction as techniques in hydrometallurgical processing is described. No attempt has been made to cover the many theoretical aspects, but rather to provide an adequate background of information and references useful to those contemplating industrial processing. Among the items covered are the techniques, reagents, equipment, processing costs, and selected extraction systems.

L'auteur traite de la purification des solutions par l'application à l'hydrométallurgie des techniques d'échange d'ions et d'extraction des solvants. Il n'est nullement question des aspects théoriques de ces méthodes, mais plutôt d'offrir les renseignements et les références nécessaires à toute entreprise désireuse d'appliquer des techniques à l'échelle industrielle. Le présent texte porte sur les techniques, les réactifs, le matériel, le coût du traitement et divers procédés d'extraction.

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Price \$1.25

Catalogue No. M38-3/237

IC272 Methods for the Removal of Sulphur Dioxide from Waste Gases

H.P. Dibbs*

A review is given of methods that have been used, or are currently being developed, for the removal of sulphur dioxide from the waste gases emitted from the combustion of sulphur-containing fuels and from the smelting of sulphide ores. These methods have been classified into ten groups based upon either the removal technique or on the type of absorbent employed in the removal process. An outline of the chemistry of the removal processes is also given together with the current stage of development of the processes.

On présente une révision des méthodes utilisées ou en voie de développement pour l'enlèvement de l'acide sulfureux des gaz brûlés dégagés de la combustion des combustibles sulfurés et de la fusion des minerais sulfurés. On classifie ces méthodes en dix groupes basés soit sur la technique de l'enlèvement soit sur le type de l'absorbant employé dans le procédé de l'enlèvement. On donne aussi un aperçu de la chimie des procédés de l'enlèvement et le point actuel du développement des procédés.

*Head, Surface Science Group, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada

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IC273 Calculation of the Corrections to the Chemical Composition of Solids in the Fluorescent X-Ray Analysis of Slurries Zavodskaya Laboratoriya, 36, 937 (1970).

A.H. Gillieson*

In the X-ray fluorescence analysis of slurries, a method is developed for the calculation of the chemical composition of the solids, which is independent of the solids content of the slurry.

*Head, Spectrochemistry Group, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

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IC274 The Determination of Calibration Functions for the Optical Emission Spectrochemical Analysis of steel by Means of Multiple Regression Calculations

Von Paul Holler , Kurt Schnick , Karl-Heinz Galda, and Christian Thoma, A.H. Gillieson* (Translator)

Characteristic features of regression calculation in its application to calibration in spectral analysis. Relevant fundamentals for the development of approximations and elimination of approximations by means of regression analyses. Elimination of non-significant factors of influence by means of the t test. Stepwise regression calculation with widened approximations for each factor in order to optimize the reduced approximations with the residual scatter as criterion. Discussion of the results in the uniform calibration of a broad steelmaking program. Application of this method to process control.

*Head, Spectrochemistry Group, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

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IC277 Maturity Concept and the Estimation of Concrete Strength - A Review

V.M. Malhotra*

The determination of strength of concrete without physically testing a specimen has been the subject of research for the past several decades. It has been suggested by several researchers that strength of concrete can be expressed in terms of the maturity, commonly defined as the product of time and temperature above - 10°C (14°F). Others have used the maturity concept to estimate strength of concrete at various ages.

This paper critically reviews the literature published on the subject since 1904 and presents results of limited investigations carried out at the Mines Branch to estimate the compressive strength of concrete at low maturities, usually associated with accelerated strength tests. The paper is concluded with a summary of the

literature reviewed and a list of pertinent references.

La détermination de la résistance du béton, sans mettre un échantillon à une épreuve physique, a été le sujet de recherches depuis un bon nombre de décades. Plusieurs chercheurs scientifiques ont suggéré que la résistance du béton pouvait être exprimée en termes de maturité, ordinairement définie comme le produit du temps et de la température au-dessus de -10°C (14°F). D'autres ont utilisé le concept de maturité pour estimer la résistance du béton à des âges différents.

Cette étude révisé critiquement la littérature publiée sur ce sujet depuis 1904 et présente les résultats des recherches limitées, effectuées à la Direction des Mines pour estimer la résistance du béton à la compression à basses maturités, procédé habituellement associé avec les épreuves accélérées de résistance. L'étude se termine avec un résumé de la littérature révisée et une liste de références pertinentes.

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Price 75 cents

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IC278 Application in the Steel Industry of Large Line-Frequency Induction Furnaces

J.E. Rehder*

Development of large induction furnaces has proceeded rapidly in the iron foundry industry, particularly in the United States. Today, 65-ton 21,000-kW furnaces are operating, and a furnace 50 per cent more powerful has been designed. These are heavy industrial furnaces that operate at line frequency and so are of reasonable capital cost, and there are many places in the steel industry where such powerful energy injectors can be valuable. Immediate application can be made, for example, to increasing blast furnace output by duplexing the hot metal with steel scrap and to making synthetic hot metal for the basic oxygen furnace (BOF) from steel scrap or from reduced pellets. Synthetic hot metal so made is free of blast furnace operating restraints and can, for example, economically substitute temperature for silicon content, making practical the specification of hot metal for maximum BOF production rate and minimum total cost.

Induction furnaces of moderate size are being used today for minor steelmaking and in vacuum degassing equipment. However the large, high-powered induction furnace has some characteristic features that have not been adequately explored for tonnage steelmaking. Important among these are the ability to emulsify slag into the molten steel to obtain very high interface area and rate of reaction, the feasibility of handling considerable slag volume with maintenance of slag temperature, and the ease of obtaining nearly continuous production. Effective application of such factors will constitute new methods of steelmaking. Processing of solid-stage reduced pellets seems particularly well suited to the induction furnace.

Il y a eu un développement rapide des gros fourneaux à induction dans l'industrie de fonderie de fonte, particulièrement aux Etats Unis; à présent les fourneaux de 65 tonnes et de 21,000 kW sont en opération, et un fourneau avec 50 pour-cent plus de force à été dessiné. Ce sont de lourds fourneaux qui fonctionnent à la fréquence de ligne qui sont par conséquent d'un coût raisonnable, et il y a plusieurs endroits dans l'industrie d'acier où de tels injecteurs à énergie puissante peuvent être utilisés, par exemple, pour augmenter le rendement du haut fourneau en ajoutant les ferrailles au métal fondu et de produire du métal en fusion synthétique pour le fourneau basique à l'oxygène (BOF) provenant de la ferraille ou des boulettes réduites. Un tel métal en fusion synthétique est libre des contraintes d'opération du haut fourneau et peut, par exemple, substituer économiquement la température pour le contenu de silicium, en rendant pratique la spécification du métal en fusion pour le rendement maximum du fourneau basique à l'oxygène et pour le coût total minimum.

A présent, les fours à induction d'une grandeur modérée sont utilisés pour la fabrication en petites quantités de l'acier, et dans l'équipement de dégazage. Cependant, le fourneau à induction a quelques capacités caractéristiques qui n'ont pas été suffisamment explorées pour la fabrication de l'acier en grand tonnage. En importance parmi celles-ci se trouvent - la capacité d'émulsionner la scorie dans l'acier pour obtenir plus de surface exposée et une réaction plus rapide, la praticabilité de manient et de maintien de la température d'un volume considérables des scories, et la facilité d'obtenir presque une production continuelle. Les applications efficaces de tels facteurs constitueront les nouvelles méthodes de faire l'acier. Le traitement des boulettes réduites et solides semble particulièrement convenable au fourneau à induction.

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IC279

Fuel Consumption and Air Pollution Trends in Canada 1965 - 1980

E.R. Mitchell*

A projection of fuel consumption to 1980 anticipates a continued strong growth rate of 6.5% per annum. Thus, it is possible that fuel consumption in 1980 will be 48.9 million tons of coal, 35.5 million of which will be needed for electric power generation, 796.5 million barrels of liquid fuels, and 2.5 trillion cubic feet of natural gas.

In describing the impact of the resulting pollution on the air environment, the paper shows that, by applying technically feasible abatement measures in 1975, about 6.9 million net tons of harmful pollution can be avoided in 1980. This reduction would be larger if, after 1970, more coal burning were not projected for thermal power generation. Despite this, the 1980 pollution burden will increase with population growth and, all things remaining equal, the 1970 level of pollution will return in the year 2004.

To accomplish this significant feat, it is roughly estimated that a

capital expenditure of \$1.6 billion will be needed by 1980 plus \$300 million per year for automobile pollution control devices starting in 1975. Despite this large expenditure the paper indicates that, in 1980: (1) the air environment will appear dirtier in the regions where coal is burned for power generation (see Appendix I, item 1), because of a 151% increase in particulate emissions even with efficient electrostatic precipitators, but cleaner in the vicinity of steel mills and mineral processes where dust collectors are being installed; (2) odours from oil refineries, paper mills, and other processes will continue but (3) the air will be more pleasant to breathe, and maybe healthier, in urban areas.

On prévoit la consommation de combustible jusqu'en 1980 à un taux toujours grandissant de 6.5% par année. Il est possible en 1980 alors de consommer en combustible 48.9 millions de tonnes de charbon, dont 35.5 millions seront nécessaires à la production d'énergie électrique, 796.5 millions de barils de combustibles liquides et 2.5 trillions de pieds cubes de gaz naturel.

En décrivant l'impact de la pollution résultante sur l'environnement atmosphérique, ce circulaire illustre qu'en appliquant des mesures d'abaissement techniquement possibles en 1975, environ 6.9 millions de tonnes nettes de pollution nuisible peuvent être évitées en 1980. Cette réduction serait plus considérable si, après 1970, la combustion de charbon n'était pas prévue pour la production d'énergie thermique. Malgré cela, le fardeau de pollution en 1980 sera 33% inférieur à celui de 1970. Après 1980, le fardeau de pollution augmentera avec l'accroissement démographique et, toutes choses restant égales, le degré de pollution de 1970 reviendra en 2004.

Pour effectuer cet exploit significatif, on estime qu'il faudra dépenser en capital 1.6 billions de dollars pour 1980 plus 300 millions de dollars par année sur les appareils pour le contrôle de la pollution causée par les automobiles commençant dès 1975. Malgré ces grosses dépenses, le circulaire indique qu'en 1980: (1) l'environnement atmosphérique paraîtra plus sale dans les régions où on utilise la combustion de charbon dans la production d'énergie (voir appendice I, article 1) à cause d'une augmentation de 151% dans les émissions de particules malgré l'aide efficace des précipitateurs électrostatiques, mais l'environnement atmosphérique paraîtra plus pur dans le voisinage des usines d'acier et de procédés minéraux où on installe des collecteurs de poussières; (2) les odeurs émanant des raffineries de pétrole, des papeteries et autres procédés continueront mais (3) l'air deviendra plus agréable à respirer, et peut-être plus sain dans les régions urbaines.

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IC280

Canadian Minerals for Refractories

M. Palfreyman*

Most of the minerals employed in Canadian refractory production are imported, in fact most of the refractories consumed in Canada are imported. Whereas this

situation is partly due to a definite shortage of suitable raw materials, e.g., fireclays, it is possible that the potential of certain mineral deposits which could be usefully exploited has not been recognized. There are exceptions, notably magnesite and dolomite, from which refractories are produced in Canada.

In many cases, known mineral deposits are located in either inaccessible areas or in areas where transportation would be a major economic factor. This paper lists some minerals and their respective known deposits which could be employed in the production of refractories irrespective of economics.

La plupart des minéraux utilisés dans la production canadienne de réfractaires est importée, en fait la plupart des réfractaires consommés est importée. Tandis que cette situation est causée en part par une pénurie de matières premières convenables, par exemple les argiles réfractaires, il est possible que le potentiel de certains gisements minéraux qui pourraient être exploités, n'a pas été reconnu. Il y a des exceptions, notamment le magnésite et la dolomite dont les réfractaires sont produits au Canada.

Dans plusieurs cas, ces gisements minéraux sont situés soit dans des régions inaccessibles soit dans des régions où le transport deviendrait un problème économique. On trouve dans ce circulaire une liste de quelques minéraux et leurs gisements qui pourront être utilisés dans la production de réfractaires sans tenir compte de leur rentabilité.

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IC281

Bibliography of High-Temperature Condensed States Research
Published in Canada, October-December, 1971

Norman F.H. Bright*

This report contains bibliographic information concerning research work on high-temperature condensed states published in Canadian journals from October 1 to December 31, 1971.

Le présent rapport contient des renseignements bibliographiques, sur les recherches effectuées sur les états condensés aux températures élevées, publiés dans les revues scientifiques canadiennes au cours de la période du 1^{er} octobre au 31 décembre, 1971.

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IC282 An Index of Scientific and Technical Papers Published by the Staff
in 1971

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IC283 Bibliography of High-Temperature Condensed States Research Published
in Canada, January-March, 1972

Norman F.H. Bright*

This report contains bibliographic information concerning research work on high-temperature condensed states published in Canadian journals from January 1 to March 31, 1972.

Le présent rapport contient des renseignements bibliographiques sur les recherches effectuées sur les états condensés aux températures élevées, publiés dans les revues scientifiques canadiennes ou cours de la période du 1^{er} janvier au 31 mars, 1972

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Catalogue No. M38-3/283

IC 284 Analytical Methods in Solvent Extraction Processing

A.W. Ashbrook*

Analytical methods for the analysis of both aqueous and organic streams in solvent extraction processes are reviewed, especially with reference to the determination of the organic components of these streams. The determination of metals is considered only briefly.

Procedures for the determination of the majority of organic reagents used in commercial solvent extraction operations are given, and areas where methods are required are indicated.

Problems associated with sampling are discussed in some detail.

On passe en revue les méthodes analytiques pour l'analyse des fluides aqueux et organiques dans les procédés d'extraction au solvant surtout pour déterminer les composantes organiques de ces fluides. La détermination des métaux n'est considérée que très brièvement.

On présente les procédés pour déterminer la majorité des réactifs organiques utilisés dans les opérations commerciales d'extraction au solvant, et on indique les régions où ces méthodes sont nécessaires.

On discute en détail les problèmes associés à l'échantillonnage.

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IC285F

L'Exploitation Minière

D.F. Coates*

Le but de l'exploitation minière est un concept très simple. Il comprend 4 différentes étapes: 1) extraire le minéral de la terre; 2) contrôler temporairement le vide résultant; 3) transporter le minéral à la surface de la terre; et 4) réduire le minéral en le concassant à une dimension avantageuse, soit pour le marché ou soit pour la poursuite d'un traitement conséquent. Ces étapes sont souvent altérées par des problèmes d'affaire ou des difficultés techniques, psychologiques et sociologiques. Il y a des aspects uniques à ces problèmes qui pourraient rendre une carrière très intéressante.

Ont dit parfois que les méthodes de base pour l'exploitation minière n'ont pas changé depuis 400 ans. Ceci est plutôt une exagération, mais on doit comprendre que l'amélioration des méthodes actuelles au point de vue efficacité est tellement grande qu'il y existe donc une différence. Par exemple, on utilise maintenant le trépan de sonde d'acier durci au lieu des bois d'un cerf tels qu'à l'âge de pierre. Aujourd'hui, dans les mines à ciel ouvert, des camions de 200 tonnes remplacent les petits sacs de cuir de l'âge du bronze. L'enlèvement de l'eau se fait maintenant avec une pompe centrifuge d'une puissance de 3000 pieds auprès des pompes à vis des anciens Grecs d'une rangée bien limitée. Tout ceci signifie que, actuellement, on peut descendre jusqu'à une demi-mille dans une excavation à ciel ouverte et plus de deux milles dans une excavation souterrain.

A l'avenir, les changements technologiques surviendront plus rapidement que dans les siècles passés. Il se peut que les frais des explosifs nucléaires soient un dixième de ceux de nos explosifs conventionnels. Déjà, on a débuté le concassage souterrain de roches (avec des explosifs nucléaires ou autrement) et l'extraction du minéral par moyen de la circulation des liquides contenant une source d'énergie bactériologique; tout ceci pourra se poursuivre sans aucun être humain soit obligé de se rendre sous-terre. L'idée de mûles automatisés et mécaniques peut devenir une réalité avec l'aide du contrôle de laser et des rayons-X.

Cependant, dans l'industrie minière du Canada, les problèmes techniques, et même ceux concernant l'écologie ne sont pas aussi grave que les problèmes sociologiques. Déjà, les mines des Territoires du Nord-Quest ne peuvent fonctionner efficacement à cause du manque d'intérêt pour aller travailler dans des endroits éloignés, mêmes durant les périodes critiques de chômage. La solution serait peut-être de faire le trajet à ces endroits par avion à réaction et d'y demeurer pour trois postes de 12 heures chaque. Il se pose aussi la question comment restreindre l'exploitation minière parvenant des pays étrangers qui désirent transformer les matières premières en produits manufacturés. Quoi qu'il arrive, il y a beaucoup d'ouvertures pour ceux qui ont l'initiative et qui sont intéressés à ces problèmes sérieux.

The function of mining is very simple in concept. It comprises the four operations of detaching the ore from the earth's crust, controlling temporarily the resultant void, transporting the ore to the surface, and crushing it to an appropriate size either for marketing or for further treatment. These operations often require the overcoming of difficult technical, business, psychological, and sociological problems. The unique aspects of many of these problems make it an interesting area for the development of a career.

It is sometimes lightly said that the basic methods of mining have not changed in 4000 years. This is somewhat of an exaggeration, but at least - it can be said that the difference in degree of effectiveness of present methods is so great that it

is now a difference of kind. For example, hardened steel drilling bits are used instead of the antler horns of the Stone Age. 200-ton trucks are used in some modern open-pit mines instead of the leather pouches of the Bronze Age. Removal of water is now done with centrifugal pumps lifting up to 3000 feet as compared to the limited range and capacity of the screw pumps of the Greeks. All of which means that today we can go down half a mile in open excavations and more than two miles in underground workings.

In the future decades technological changes will occur much more rapidly than in the past centuries. It is possible that nuclear explosives will be used at a cost of perhaps one tenth of conventional explosives. Breakage of rock underground (with nuclear explosives or otherwise) and the extraction of metal values by the circulation of fluids containing energetic bacteria, without any human being having to go underground, has already started. Laser control and X-ray sensing may make automated, mechanical moles feasible.

However, the technical problems, and even the environmental problems, may not be as critical to mining in Canada as the sociological problems. Already mines in the Northwest Territories cannot be operated effectively owing to the disinclination of labour to work, even during periods of high unemployment, in remote areas. The solution might be to commute to such locations a thousand miles by jet and work three 12-hour shifts. The question of restricting foreign exploitation of such resources and the desire to process the raw materials into finished products will remain complex. In any event, there is no lack of scope for those interested in tackling meaningful problems.

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Prix 50 cents

No. de catalogue M38-3/285F

(CORRIGE)

IC286

Polishing Procedures for Ore Minerals, Mill Products, and Synthetic Materials in the Mineralogy Group

P. O'Donovan*, J.H.G. Laflamme** and R.G. Pinard***

The current procedure for the preparation of polished sections of ore specimens, mill products, and synthetic materials in the Mineralogy Group of Mineral Sciences Division, Mines Branch, is described. It involved sawing the specimen, mounting it in resin in suitable moulds, preparing the specimen for polishing by grinding and impregnating, machine polishing, and finally buffing it on a cloth lap to remove fine scratches. The reasons for each step in the procedure are discussed, so that the procedure can be modified to accommodate different conditions and equipment.

On décrit le procédé courant pour la préparation des coupes polies des minéraux métalliques, des produits d'usine, et des matériaux synthétiques fait par le Groupe de minéralogie de la Division des sciences minérales, Direction des mines. Cela implique que l'échantillon soit scier, qu'il soit monté dans la résine et dans les moules convenables, que l'échantillon soit préparé pour le polissage par le meulage et l'imprégnation, le polissage mécanique et enfin qu'il soit poli sur un chiffon qui couvre le disque de polissage pour enlever les égratignures fines. On discute de la raison pour chaque étape du procédé, afin que le procédé puisse être modifié pour accommoder les différentes conditions et l'équipement.

*Technical Officers, Mineralogy Group, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 50 cents

Catalogue No. M38-3/286

IC287 Evaluation of Canadian Commercial Coals: Nova Scotia and New Brunswick - 1971

T.E. Tibbetts* and W.J. Montgomery**

Physical and chemical analyses of eighty-nine coal samples are reported, representing the eight operating mines in Nova Scotia and six operating mines in New Brunswick.

The samples were taken and analysed by the Fuels Research Centre during the year 1971. They represent the production on a specified day of the coals as commercially prepared at the mine or the coals as delivered to thermal electric generating stations.

Les auteurs donnent les résultats des analyses chimiques et physiques de 89 échantillons de houille provenant de 8 mines en exploitation en Nouvelle-Ecosse et de 6 mines au Nouveau-Brunswick.

Les échantillons ont été prélevés et analysés en 1971 par le Centre de recherches sur les combustibles. Ils sont représentatifs de la production journalière de la houille préparée commercialement à la mine ou livrée aux centrales thermiques.

*Head, Coal and Peat Resources Evaluation Section and ** Head, Solid Fuels Laboratory, Fuels Research Centre, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price \$1.00

Catalogue No. M38-3/287

IC288 Mineralogical Investigation of an Antimony-Arsenic Ore from the Card Lake Copper Mines Limited, Timmins Area, Ontario.

R.G. Pinard*

A mineralogical study was made on samples from an antimony-arsenic deposit located 35 miles west of Timmins, Ontario and four miles south of Highway 101. The results show that the samples contain antimony and arsenic minerals in silicates. The main antimony mineral is berthierite and the main arsenic mineral is arsenopyrite. The berthierite is present as relatively large grains and the arsenopyrite as clusters of minute grains. Other significant antimony minerals are stibnite, native antimony, and the oxides-valentinite, romeite, and an unidentified oxide. Other minerals found in the samples are pyrrhotite, chalcopyrite, ullmannite, tetrahedrite, tennantite, pyrite, marcasite, covellite, and scorodite. The gangue consists of quartz, chlorite, mica, amphibole, sphene and dolomite.

L'auteur a fait une étude minéralogique sur les échantillons d'un gisement d'antimoine-arsenic situé à 35 miles à l'ouest de Timmins, Ontario et à 4 miles

au sud de la route 101. Les résultats indiquent que les échantillons contiennent des minéraux d'antimoine et d'arsenic dans les silicates. Le minéral principal d'antimoine est la berthiérite et le minéral principal d'arsenic est l'arsénopyrite. La berthiérite est présente sous forme de grains relativement gros et l'arsénopyrite sous forme de groupe de grains minutieux. Les autres minéraux importants d'antimoine sont la stibnite, l'antimoine natif et les oxydes de valentinite et de roméite et un oxyde non identifié. Les autres minéraux trouvés dans les échantillons sont la pyrrohotite, la chalcopyrite, l'ullmannite, la tetraédrite, la tennantite, la pyrite, la marcasite, la covellite et la scorodite. La gangue se compose de quartz, de chlorite, de mica, d'amphibole, de sphène et de dolomite.

*Technologist, Mineralogy Group, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 50 cents

Catalogue No. M38-3/288

IC289 Bibliography of High-Temperature Condensed States Research Published in Canada, April - June, 1972

Norman F.H. Bright*

This report contains bibliographic information concerning research work on high-temperature condensed states published in Canadian journals from April 1 to June 30, 1972.

Le présent rapport contient des renseignements bibliographiques sur les recherches effectuées sur les états condensés aux températures élevées, publiés dans les revues scientifiques canadiennes au cours de la période du 1^{er} avril au 31 juin, 1972

*Head, Physical Chemistry Group, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 50 cents

Catalogue No. M38-3/289

IC290 Analyses of Coal during 1971

W.J. Montgomery* and G.C. Anderson**

The Solid Fuels Laboratory of the Fuels Research Centre is responsible for all analytical work on coal encompassed by this publication. This information circular, issued as the eleventh of an annual series, tabulates the analyses of coal samples analyzed by the Centre during 1971.

It must be clearly understood that no responsibility is taken by the Centre for the accuracy of the sampling procedures adopted for procuring the samples for which analyses are reported in this circular, excepting those taken by Centre Officers.

Proximate analysis and sulphur values are reported on the "as received" basis only, whereas calorific values are reported on the "as received" as well as the "dry" basis. As an easy reference, the analyses are arranged by province and state.

Le laboratoire des combustibles solides, au Centre de recherches des combustibles, s'occupe de tous les travaux analytiques sur le charbon mentionnés par la présente publication. Cette circulaire d'information, la onzième d'une série qui doit paraître annuellement, traite des analyses d'échantillons de charbon analysés par le Centre au cours de 1971.

Il faut bien se rappeler que, sauf pour les échantillons prélevés par ses propres fonctionnaires, le Centre n'assume aucune responsabilité en ce qui concerne l'exactitude des techniques d'échantillonnage adoptées pour obtenir les échantillons dont les analyses sont considérées dans la présente circulaire.

On indique les analyses quantitatives approximatives et les teneurs en soufre des échantillons "tels qu'ils nous sont parvenues" seulement, tandis qu'on mentionné les valeurs calorifiques des échantillons "tels qu'ils sont reçus" et aussi "à sec". Pour les fins de référence, les analyses sont classées par province et par état.

*Head, Solid Fuels Laboratory, and **Technician, Fuels Research Centre, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada

Price 50 cents

Catalogue No. M38-3/290

IC292 Surface Mining Practice in Canada

Amil Dubnie*

Examination of the practices in 52 Canadian surface mines shows a marked similarity in equipment, procedures, and productivity.

The unit operations of planning, stripping, breaking, and haulage are analyzed. The high degree of mechanization in the surface mines is conducive to a labour productivity which is several times that for underground mining.

As replacements occur, the established trend towards larger equipment tends to reduce surface mining costs. As a result, the increased use of surface mining methods in the recovery of minerals appears assured.

L'étude des méthodes utilisées dans 52 mines canadiennes à ciel ouvert révèle une ressemblance remarquable dans le matériel, les procédés et la productivité.

L'auteur analyse la planification, le décapelage, l'abattage et le transport. Le haut degré de mécanisation dans les mines à ciel ouvert contribue à une productivité de la main-d'oeuvre bien supérieure à celle de la main-d'oeuvre des mines souterraines.

La tendance à installer du matériel plus lourd lors des renouvellements contribue à réduire les coûts d'exploitation à ciel ouvert. En conclusion, l'emploi croissant de méthodes d'extraction à ciel ouvert des minéraux semble certain.

*Mining Engineer, Mining Research Centre, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price \$3.00

Catalogue No. M38-3/292

IC293 Bibliography of High-Temperature Condensed States Research Published
in Canada, July - September, 1972

Norman F.H. Bright*

This report contains bibliographic information concerning research work on high-temperature condensed states published in Canadian journals from July 1 to September 30, 1972.

Le présent rapport contient des renseignements bibliographiques sur les recherches effectuées sur les états condensés aux températures élevées, publiés dans les revues scientifiques canadiennes au cours de la période du 1^{er} juillet au 30 septembre, 1972.

*Head, Physical Chemistry Group, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 50 cents

Catalogue No. M38-3/293

IC294 Standard Reference Ores and Rocks Available from the Mines Branch

G.H. Faye*

The current Mines Branch program of producing standard reference ores and rocks is an offshoot of the activities of the Canadian Association for Applied Spectroscopy (CAAS) which, in 1955, set out to produce copper and copper-alloy standards with the assistance of the Mines Branch and various Canadian metallurgical industries.

In 1966, the CAAS which has since become the Spectroscopic Society of Canada (SSC) entered the geochemical field by issuing a syenite rock (SY-1) and a sulphid ore (SU-1) as reference materials with provisional certificates of analysis. The Mines Branch became more actively involved in the standards program in 1968 by preparing two further syenite rock standards, SY-2 and SY-3, as replacements for the exhausted supply of SY-1. This work set the stage for the transfer, in 1969, of the production of standard reference materials from the SSC to the Mines Branch. Such an activity is logical for the Mines Branch because it has the necessary personnel and equipment not only for production but for distribution and sales. Because of its impartiality, the Mines Branch can easily co-ordinate the inter-laboratory programs that are necessary to obtain analyses for the certification of standard reference materials.

Between 1967 and 1970, it became increasingly apparent that a need existed for standard reference ores that were typical of major deposits in Canada. Consequently, the Mines Branch has recently undertaken to produce a number of standard ores which, it is hoped, will be of value not only to analysts but to other workers in the earth sciences. Materials that have been made available for sale within the past eighteen months include: plantiniferous materials PTA and PTM; molybdenum ore PR-1 and a zinc-tin-copper-lead ore MP-1. Other ores are in the process of being characterized and certified.

This circular describes the standard reference ores and rocks that may be purchased from the Mines Branch, through the Standards Co-ordinator, Mineral Sciences Division, as of late 1972. Where possible, the source, mineralogical and chemical composition, the recommended values of the certified elements, and the price are given for each available material. Also included are brief descriptions of materials that are being processed and their approximate

date of availability.

It is anticipated that this circular will be revised and enlarged as new information on existing materials becomes available and as new standard ores are added to the list.

*Group Leader, Inorganic and Analytical Chemistry Research Group, Mineral Sciences Division,
Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 75 cents

Catalogue No. M38-3/294

REPRINT SERIES

RS107 Solvent-in-Pulp Processing Using Sieve Plate Pulse Columns

G.M. Ritcey*. Reprinted from Chemistry and Industry, 6 November 1971.

*Research Scientist, Head of Solution Treatment, Extraction Metallurgy Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 25 cents

Catalogue No. M38-8/107

RS108 The Effects of Sintering Atmosphere on the Properties of Strontium Ferrite Permanent Magnets

Sutarno, W.S. Bowman* and G.E. Alexander**. Reprinted from Canadian Ceramic Society, Vol. 40, pp 9 to 14, 1971

The effects of variations in the partial pressure of oxygen in the sintering atmosphere on the ceramic and magnetic properties of strontium ferrite ceramic magnets have been investigated. It was found that, at given sintering parameters (i.e. temperature, time, heating rate, etc.), the increase of oxygen partial pressure reduced the degree of sintering, and consequently decreased the remanent magnetization and increased the coercive force.

*Research Scientist; **Technical Officer, ***Electronics Technologist, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 25 cents

Catalogue No. M38-8/108

RS109 Analysis of Accuracy in the Determination of the Ground-Stress Tensor by Means of Borehole Devices

W.M. Gray* and N.A. Toews**. Reprinted from Proceedings, Ninth Symposium on Rock Mechanics, Colorado School of Mines, 17 to 19 April, 1967

The determination of the state of stress existing at a point in any solid body requires the determination of the six components of the stress tensor relative to a convenient set of axes. One general method of doing this in rock is to make strain or deformation measurements associated with local relief of stress in a number of boreholes penetrating a limited volume in the vicinity of the point at which the stress is to be determined. The stress is assumed to be constant throughout this volume.

Leeman¹ has described a number of the instruments that have been developed for making deformation or strain measurements in boreholes. Panek² has described the application of statistical methods to the determination of the average components of ground stress from sets of measurements made in boreholes by means of deformation meters of the type developed by the U.S. Bureau of Mines.

In this paper, attention is given initially to the strain cell developed for use on the flattened ends of boreholes by the Council for Scientific and Industrial Research (CSIR), South Africa. The equations required for evaluating the average components of ground stress from measurements made by means of the CSIR strain cell are derived.

These equations are similar in form to those applying to measurements made by the borehole deformation meter developed by the U.S. Bureau of Mines.

The results of an investigation of the properties of the equations are described. These results are important in the practical use of both the instruments mentioned above and any instrument based on similar principles.

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Price 25 cents

Catalogue No. M38-8/109

RS110 Stress Determination from Strain Relief Measurements on the Ends of Boreholes; Planning, Data Evaluation, and Error Assessment

W. M. Gray* and K. Barron**, Reprinted from Proceedings, International Symposium on Determination of Stresses in Rock Masses, Lisbon, 19 to 21 May, 1969.

The method of strain-relief measurement on the flattened ends of boreholes is a relatively economical means for determining stress deep in rock. Experience with the method has enabled the mechanical and statistical problems of instrument design, planning the measurement system, evaluating the results and assessing the errors to be better appreciated.

Use of a four-element 45-degree strain-gauge rosette is recommended. Borehole configurations for optimum precision with this and other rosette designs are given. Since it may be impractical to use an optimum configuration at a given site, a series of layouts suitable for a variety of sites is presented. An order of preference is given, Experimental methods of checking the validity of strain measurements and a statistical method for final screening of data are given.

Currently, the greatest errors in the method are caused by uncertainty about the values of the calibration factors or stress concentration factors associated with flat ended boreholes. A review of recent work on this problem has yielded recommended calibration factors, with their degree of uncertainty. The sensitivity of the calculated stress components to the values of the calibration factors is illustrated by an example.

La méthode de mesure du soulagement de déformation sur les fonds aplatis des trous de sondage est un moyen relativement économique de déterminer la contrainte de la roche en profondeur. L'expérience avec cette méthode a permis de mieux reconnaître les difficultés mécaniques et statistiques de la conception des appareils, de l'ordonnement du système de mesure, de l'évaluation des résultats et des erreurs.

On recommande l'emploi d'une rosette extensométrique à 45 degrés à 4 éléments. On indique des configurations de trous de sondage donnant la meilleure précision avec ce modèle de rosette et d'autres modèles. Comme il peut ne pas être pratique d'utiliser une configuration optimale à un endroit donné, on présente une série d'agencements adaptables à divers emplacements avec leur ordre de préférence. On a aussi inclus des méthodes expérimentales pour vérifier la validité de mesures de déformation ainsi qu'une méthode statistique d'analyse finale des résultats.

Actuellement, les plus grandes erreurs de cette méthode sont causées par l'incertitude sur les valeurs des facteurs de calibrage ou des facteurs de concentration de contrainte correspondant aux trous de sondage à fond plat. Une revue des récents travaux sur cette question a indiqué des facteurs d'étalonnage recommandés, avec leur degré d'incertitude. Un exemple illustre la sensibilité des composantes de contrainte, calculées,

par rapport aux valeurs des facteurs d'étalonnage.

*Research Scientists, Mining Research Centre, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 25 cents

Catalogue No. M38-8/110

RS111 The Use of Arsenazo (III) in the Determination of Total Sulphur in Coal by the Oxygen Flask Method

S.M. Ahmed*, and B.J.P. Whalley*. Reprinted from Fuel, Vol. 48, No. 2, pp 217 to 219, 1969.

The oxygen flask method for determining sulphur in organic compounds has been used for several years. It has also been applied to the determination of total sulphur in coals by the B.C.R.A. and by D.B. Ratcliffe and A.T.S. Cunningham using Thorin as titration indicator. Despite the simplicity of the apparatus and technique, the method has not been widely adopted for coals partly because it has lacked an indicator displaying a sharp colour contrast at the end-point, thus restricting its use to experienced analysts. Recently S.B. Savvin et al. and K. Hozumi and K. Umemoto have pointed out that a new indicator Arsenazo (III) gives a much more definite end-point than Thorin when used in analysing essentially pure organic compounds for sulphur content. Moreover the end-point is a reversible one.

Saskatchewan lignite, being an important Canadian energy resource, has been studied extensively by the Canadian Combustion Research Laboratory (CCRL), and in recent years research has been carried out on a pilot-scale, pulverized-fired steam boiler to study its combustion performance, air pollution emission, low-temperature corrosion potential, and fireside fouling tendencies under slag-tap conditions. Concurrently, similar research was carried out on Onakawana lignite from an undeveloped mine in the James Bay area.

The present report summarizes the results of combustion performance and fireside fouling for both fuels. Although of the same rank, these two lignites differ substantially in physical structure and, more important, in their fouling characteristics. Extensive analysis of fly-ash samples obtained progressively through the boiler system indicate that this may be due to selective deposition of certain ash constituents, leading to enrichment of others.

*Research Scientist, Canadian Combustion Research Laboratory, Fuels Research Center, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 25 cents

Catalogue No. M38-8/111

RS112 Combustion and Fouling Characteristics of Two Canadian Lignites

*F.D. Friedrich, *G.K. Lee and E.R. Mitchell**. Reprinted from Transactions of the ASME. Journal of Engineering for Power Vol. 94, Series A No. 2, pp 127 to 132, April 1972.

The report describes combustion tests with Bienfait lignite from Saskatchewan and Onakawana lignite from James Bay. They were burned in a pilot-scale, pulverized-fired boiler primarily to study combustion performance and fireside fouling tendencies under slag-tap conditions. Flame stability and complete combustion were readily obtained, although satisfactory slag tapping was not achieved with either fuel. Fireside ash deposit samples, representing each fuel, were collected from various parts of the boiler and subjected to exhaustive analyses. The results indicate that, when burning Bienfait lignite, selective deposition of ash constituents takes place, resulting in a eutectic composition downstream of the furnace exit. In the case of Onakawana lignite, selective ash deposition did not occur. Deposit analyses, fusion temperatures, and enrichment ratios are given for both fuels.

*Research Scientist, **Head, Canadian Combustion Research Laboratory, Fuels Research Center, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 25 cents

Catalogue M38-8/112

RS113 Analysis of Grading Effects on Hydraulic and Consolidated Fill

D.F. Coates*, and Y.S. Yu*. Reprinted from CIM Transactions, Vol. LXXII, pp 36 to 41, Montreal 1969.

The Mining Association of Canada has suggested that research should be conducted on fill. It is known that by changing the size distribution of fill its physical properties can be modified. Consequently, following a literature survey and the drafting of tentative specifications for percolation testing, some engineering studies have been made to identify the modifications that have the greatest probability of cost savings.

The in-place density of most fills could be increased by modifying the grain size distribution. By increasing the density, the volume of stope filled by a ton of fill is decreased, the stiffness of the fill is increased, the percolation rate is decreased and the amount of Portland cement required for consolidation may be decreased. These preliminary studies indicate that the minimum increased cost of producing significantly modified fill from typical mill tailings would be 6 cents per ton of fill or 4.5 cents per ton of ore. Whereas the stiffness would be increased two to three times, it would still be highly compressible compared to ore pillars and consequently would not likely have much effect on ground control costs. In consolidated fill, whereas strength would be increased, it is unlikely that the cement could be reduced below a 1/30 ratio without eliminating significant cementing action; consequently, only where higher cement contents are being used could savings of possibly 50 cents per ton of fill result.

It has been established that approximate percolation rates can be predicted from the grading, which could be useful for comparative studies.

The grading requirements for a filter to permit water to exit freely from a granular mass but to prevent the fine particles from being carried away are well established. It is possible that the use of filters at bulkheads or to receive decanted water might be less costly than cleaning the slimes out of the haulageways.

Whereas the equivalent viscosity of a fill pulp can be changed many-fold by changing the gradation of the fill, it is shown that for typical pulps the effect on the friction factor in pipes and boreholes is relatively small, so that little advantage

is indicated for any attempts to optimize this property.

In conclusion, it seems that current practices produce gradings of typical mill tailings fill that are not far from the optimum under present economic conditions.

Mine Fill System Design Based on Optimization

D.F. Coates* and M. Gyenge**. Reprinted from CIM Special Vol. 12, pp 284 to 391, Montreal, 1971.

An optimization computer program has been developed in order to solve multi-variable problems with non-linear functions. The resultant program can handle substantially any number of variables and it is readily adaptable for actual conditions.

As a sample multi-variable design problem, the optimization of a simplified mine-fill transportation system was analysed.

From several possible parameters, the following four variables were selected and manipulated during this study: (1) the diameter of the vertical borehole, (2) the diameter of the horizontal steel pipe, (3) the duration of the filling operation in hours per day and (4) the solids concentration in the slurry.

It was found that the optimum cost solution obtained by the analyses resulted in borehole and pipe sizes that are very close to those currently being used in practice for the given conditions.

*Head, **Research Scientists, Mining Research Centre, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 25 cents

Catalogue No. M38-8/113

RS114 Fireside Corrosion and Pollutant Emission from Crude Oil Combustion

G.K. Lee*, E.R. Mitchell**, F.D. Friedrich*, and R.G. Draper***. Reprinted from Transactions, ASME. Journal of Engineering for Power, Vol. 94, Series A, No. 2, pp 154 to 158, April 1972.

In North America the demand for fossil fuels in general and low-sulphur fuels in particular is rapidly increasing. It is in this context that the Canadian Combustion Research Laboratory (CCRL) carried out a detailed evaluation of the suitability of a western Canadian mixed-blend crude oil for power generation. The evaluation included an analytical investigation of fuel properties and studies of both the fireside corrosion and pollution potential of this fuel under controlled combustion conditions in the CCRL pilot-scale research boiler.

Fuel analyses completed during the course of a 70-hr combustion test showed that the as-received crude oil contained a rather low concentration of water-soluble chloride salts; namely, 73 lb/1000 bbl of oil. Since chlorides were considered to be the most likely cause of severe high-temperature corrosion, a second 70-hr test was carried out, in which the chloride content was increased to 376 lb/1000 bbl of oil by injecting a solution of 2.7 per cent sodium chloride and 0.5 per cent magnesium chloride into the furnace, just above the burners.

This report describes the evaluation procedures used and the experimental results obtained during both tests.

*Research Scientists, **Head, ***Head of Petroleum and Gas Laboratory, Canadian Combustion Research Laboratory, Fuels Research Center, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 25 cents

Catalogue No. M38-8/114

RS115 Nomenclature in the Solvent Extraction Field

A.W. Ashbrook* and G.M. Ritcey**. Reprinted from Canadian Mining Journal, pp 70 to 72, May 1972.

An attempt to define solvent extraction terms. The purpose is to avoid jargon which normally creeps into the terminology of any new field - some of which may be fine, but some of which is not always sufficiently descriptive. This article follows one by Ritcey, on the use of solvent extraction for base metals, published in the June 1969 issue of CMJ which prompted many enquiries from various parts of the world.

*Assistant Head, Chemical Analysis Section, **Research Scientist, Hydrometallurgy Section, Extraction Metallurgy Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 25 cents

Catalogue No. M38-8/115

RS116 Calcination of Gibbsite

T.A. Wheat*. Reprinted from the Journal of the Canadian Ceramics Society, Vol. 40, pp 43 to 48, 1971.

Data are presented showing the changes in physical properties which occur during the calcination of Bayer process gibbsite at temperatures up to 1400° C. The various stages of the calcination were examined using differential thermal analysis, X-ray diffraction, low-temperature nitrogen adsorption, optical and electron microscopy, and particle-size distribution analyses. The morphology of the gibbsite aggregates was found to be unchanged up to 1100° C, despite the development of several intermediate metastable phases. At higher temperatures, the original gibbsite pseudomorphs become microporous coincident with the development of finely divided alpha-alumina which is formed in a strain-free state. The crystal size and pore size increase with temperature between 1100 and 1400° C. The influence of the parent gibbsite structure on the morphology of the alpha-phase material is demonstrated in scanning-electron micrography. The effect of various parameters on the milling of high-temperature calcines is also discussed.

*Research Scientist, Ceramic Section, Mineral Processing Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Price 25 cents

Catalogue No. M38-8/116

RS117 Analysis of Total Sulphur in Canadian Coals by a Modified Oxygen-Flask
Method Using Arsenazo (III)

S.M. Ahmed* and B.J.P. Whalley**. Reprinted from Fuel, Vol. 51, pp 190 to 193, 1972.

A modified oxygen-flask method, for total sulphur analysis using Arsenazo (III) as titration indicator and Chromel 'A' wire as combustion-grate material, has been used to analyse twelve Canadian coals of widely differing rank, ash, and sulphur content. The results indicate that the method is generally applicable to coal sulphur analysis. The end-point unlike that of Thorin is sufficiently definite to permit use of the method by relatively untrained analysts. The precision of the method appears to be similar to that of the Eschka method.

*Chemist and **Research Scientist, Metals Reduction and Energy Centre, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

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Catalogue No. M38-8/117

RS 118 Solubility & Equilibrium Data for Phenol-Aqueous Sodium Salicylate-a-
Methyl Naphthalene System

S.M. Ahmed* (Co-Author). Reprinted from Indian Journal of Technology, Vol. 5, No. 7, pp 215 to 217, 1967.

Solubility and equilibrium data for phenol-aqueous sodium salicylate (54 per cent)-a-methyl naphthalene system at 30^o C are reported. The system exhibits two types of curves -- the ordinary bite-type curve and a small convex loop with a solid and liquid phase -- typical of systems containing water and an inorganic salt. The tie-line data fit with most of the empirical relationships reported in literature. The plait point for the system is at 36.0 per cent phenol concentration.

Laboratory Studies on Solvent Extraction of Low-Temperature Tar Oil
by Aqueous Sodium Salicylate

S.M. Ahmed* (Co-Author). Reprinted from Journal of Applied Chemistry, Vol. 20, No. 8, pp 252 to 255, August 1970.

The use of aqueous saturated sodium salicylate for the extraction of tar acids from a low-temperature tar fraction is discussed. Solubility and equilibrium data for the system: neutral oil-tar acids-aqueous sodium salicylate when plotted on a ternary diagram showed two types of curves: an ordinary bite-type and another a loop containing solid and liquid phases. The tie-line data agree with most of the empirical relationships reported in the literature. The plait point for the system had a tar acid concentration of 47%. The results have been compared with the earlier data for the system: phenol-a-methylnaphthalene-aqueous sodium salicylate.

*Chemist, Metals Reduction and Energy Centre, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

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RS119

The Dispersion of Multiple Plumes From a Large Thermal Generating Station

H. Whaley*, G.K. Lee*, L. Shenfield**, M.S. Hirt***, and S.G. Djurfors****.

Reprinted from Proceedings, Eighth World Energy Conference, Bucharest, Romania, Division 2, Paper 2.3 to 85, 28 June to 2 July, 1972.

Energy forecasts for the world at large indicate that electric power consumption will at least quintuple by the year 2000. Projections also show that a substantial portion of the increase will be met by large thermal generating stations, burning coal and oil, which may contribute heavily to atmospheric pollution. Unfortunately, processes presently available for controlling such pollution at the source have not received widespread acceptance, and, until technological breakthroughs occur, there is no alternative but to disperse large quantities of combustion products into the atmosphere by properly designed tall stacks. Such stacks effectively utilize the natural dispersion capacity of the atmosphere to assimilate pollution, reducing the ground-level pollutant concentrations. However, detailed information on the effect of atmospheric processes on the dispersion of pollutant plumes is still fragmentary and extensive research in this field is urgently required. One approach is to compare measured data with empirical equations. This is done in this paper for the case of multiple plumes from a 2400-MW(e) thermal generating station. The present data, which were obtained during two helicopter flights, relate emission source data, local meteorological measurements, and SO₂ distribution in the plume under the two atmospheric conditions which occurred on August 25, 1969, and May 29, 1970.

*Research Scientists, Fuels Research Centre, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada;

**Chief, Air Quality and Meteorology Division, Ontario Department of Energy and Resources Management, Toronto, Canada;

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****Meteorologist, Ontario Hydro, Toronto, Canada.

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