The 1980 Coal Processing School

by Z. ZITRON*

In 1978 the South African Coal Processing Society (SACPS), together with the Institute for Energy Studies of the Rand Afrikaans University, ran a school on coal processing. This was judged by both the organizers and the participants to have been extremely successful. As a result, it was decided to hold a second coal school in 1980. This took place in September, and was organized by SACPS, the Chamber of Mines of South Africa, and the Bernard Price Institute of Palaeontological Research of the University of the Witwatersrand.

The emphasis was on coal petrography (the microscopic constituents and properties of coal) and coal beneficiation. Two guest lecturers came from overseas. They were Professors M.-Th. Mackowsky and R. E. Zimmerman. Professor Mackowsky is with the Bergbau-Forschung of Essen, West Germany, and is the co-author of a standard work on coal petrography, and Professor Zimmerman is the coal-preparation editor of *World Coal*. South African speakers also gave papers on selected topics.

One of the highlights of the course was the launching of the third edition of the textbook *Coal Preparation* (which is available from SACPS, P.O. Box 61457, Marshalltown 2107). This textbook has already run through two editions and is also available in Afrikaans.

Professor Mackowsky recalled that the present energy situation made it advisable to replace oil by other sources such as coal. She described how a knowledge of coal petrography assists in the choice of the best coal available for any given project. The petrographic constituents of a coal depend on the environment in which the coal originated and in which the original ingredients became transformed to coal, especially temperature, time, and pressure. The macerals, as the constituents of coal are known, have different properties that affect the properties of the coal of which they are a part. The mineral impurities are also important. Thus, the impurities found in South African coal do not impair its suitability as a feedstock for certain oil-from-coal processes. Many foreign coals, which on the basis of their analysis appear to be quite suitable, are in fact unsuitable. The way in which coal petrography can assist in the evaluation of mining and coal-cleaning problems, and its application to power generation, combustion, conversion, coking, direct reduction, etc., were discussed at considerable and illuminating length.

Speakers well known in the South African coal industry gave papers on coal prospecting, mining, sampling, and analysis. The foundations of coal preparation were reviewed, and Professor Zimmerman spoke on trends in coal preparation both in the U.S.A. and elsewhere. In the U.S.A., annual coal production is expected to increase from the present value of 8000 Mt to 1500 Mt by 1990. At present, only about 40 per cent of U.S. coal is washed, since the coal in the western states has a sufficiently low ash content in its raw state to make cleaning unnecessary. However, the stringent standards now relating to sulphur emission mean that eastern coals will have to be washed to a greater extent than before. Professor Zimmerman estimated that about 175 new coal plants will be built in the next decade, excluding replacements for existing plants. In future, a higher percentage of coal will be washed than at present because of the lower grades to be mined, the increased costs, which are enforcing efficiency, and the greater use of mechanized mining, which results in more stones being sent to the surface.

Most coal cleaning today is done by jigs or dense-medium methods, with about 5 per cent being cleaned by froth flotation. In the U.S.A., about 11,5 per cent is cleaned by tabling, which is virtually unknown in South Africa as a method of coal preparation. Dense-medium methods are coming increasingly to the fore owing to their ability to treat difficult coals. Froth flotation is attracting attention as far as fine coals are concerned, but at present its efficiency does not always match the hopes it raises. Very large cells (36 m^3) are being considered. Small-diameter hydrocyclones are being investigated, as are dense-medium cyclones, tables, and Batac jigs. Oil agglomeration has not yet been attempted commercially.

In Australia, coking coals are separated from non-coking coals by size or selective breakage.

In the U.S.A., considerable thought is being devoted to the removal of sulphur. The problem is that a very large fraction of the sulphur is present in the form of organic sulphur, rather than in the form of pyrite, which presents fewer problems in its physical beneficiation. The Department of Energy of the U.S. Bureau of Mines is working on the flotation of pyrite from prefloated coal, for use where the coal contains sulphur in the form of pyrite.

Much thought is being devoted to the clarification of water in the U.S.A. as a result of the imposition there of stricter controls on effluents, and water treatment and water disposal are responsible for a large part of the costs involved in many undertakings. This probably foreshadows what will occur in South Africa. New thickeners in which the feed is pumped into the thickener via the bottom and then percolates up through the settling zone are claimed to be much more effective than the conventional type.

Screen-bowl centrifuges are creating much interest. One user has found that very fine solids that would normally report in the liquid can be made to report in the solids by the addition of oil to the feed.

Mr D. W. Horsfall spoke on the treatment of fine coal, which is discarded at present or is sold untreated with a resulting high loss of revenue. Discussions were held on the dewatering of fine coal, and also on the use of centrifuges.

Lectures were given on the level of coal preparation

*Assistant Coal Preparation Engineer, Anglo American Corporation of South Africa Limited. P.O. Box 61587, Marshalltown, Transvaal.

required for coals put to various uses. Mr T. Barnes commented on the change in attitude regarding the washing of power-station coals. It has been felt for many years that the loss of combustible matter in the discarded material outweighed the advantages in the burning of a washed coal, but the stricter standards of sulphur emission and the increased abrasiveness of unwashed coals (as a result of mechanized mining), together with the fact that washing allows the best coal to be sold to users of low-ash coal (thus lowering the costs to the power station), are giving rise to serious reconsideration of the matter. Thought is also being given to the cleaning of colliery discards for use in power stations.

The final week of the school was devoted to tours and detailed discussions of three of the latest coal plants: Kleinkopje, Rietspruit, and Ermelo. The participants in the 1980 school regarded the school as a success, and much credit is due to the organizing committee, which was headed by Professor M. A. Raath and Mr D. W. Horsfall.

NIM reports

The following reports are available free of charge from National Institute for Metallurgy, Private Bag X3015, Randburg, 2125 South Africa.

Report no. 1958

A mineralogical investigation of sulphide-bearing chromitite from the Loskop Dam area.
(10th Feb., 1978; reissued 1st Dec., 1980).

The Loskop chromite is composed of chromite crystals (median diameter 100 μm, mean diameter 150 μm) embedded in a silicate matrix composed of orthopyroxene, plagioclase, amphibole, chromite, talc, saussurite, phlogopite, muscovite, and sulphides. The ore has a chromium-to-iron ratio of 1,2, its Cr_2O_3 content being 26 to 29 per cent and its noble-metal content (platinum-group metals and gold) 4,06 p.p.m. The chromite crystals when unaltered have a chromium-to-iron ratio of *ca* 1,4, and a Cr_2O_3 content of *ca* 43 per cent. Alteration of the chromite in the direct vicinity of leucocratic diopside–plagioclase veins and in areas where muscovite-rich pegmatitic material has developed reduces the chromium-to-iron ratio of the chromite to *ca* 1 and the Cr_2O_3 content to below 40 per cent. Visible sulphides rich in nickel are present in the ore where muscovite becomes a major component.

Report no. 2067

List of unrestricted NIM publications issued from 1966 to 1980.

This publication lists the 742 unrestricted reports, 337 papers, 26 patents, and 4 other technical publications that were issued as publications of the National Institute for Metallurgy (NIM) from 1966 (the year of its inception) to 1st April, 1980. For ease of reference, these publications are also classified under research topics.

Also included are details of the 2 periodicals issued by NIM and a list of the current miscellaneous publications of the Institute, which include the annual report, and brochures and leaflets of various kinds.

Report no. 2076

Wet high-intensity magnetic separation. Laboratory tests conducted in 1978 and 1979.

Miscellaneous laboratory tests (most of them on cyanide residues) were undertaken to supplement on-site pilot-plant work on wet high-intensity magnetic separation (WHIMS). Initially, the main concern was with blockage of the matrix, and consideration was given to the use of a reverse-flushing system. The laboratory tests on this system were encouraging, but they were not of sufficiently long duration to be conclusive.

When the continuous ball-discharge and washing system was developed at the National Institute for Metallurgy, the blockage problem lost its urgency, and the laboratory work was applied to an investigation of the performance of WHIMS machines. The laboratory tests were the 'standard' test (developed to provide a simple and highly reproducible test), a batch test with free-fall feed, a batch test with controlled feed (up-flow), and a continuous test using a Carpco laboratory separator. Each of these methods is suitable for a particular purpose. The Carpco separator gives low recoveries because of its shallow matrix, but the recovery to be expected in practice can be matched if the feed is passed twice through the separator.

The velocity of the pulp through the matrix is important, because it determines the capacity of the separator and the recovery obtainable. Of almost equal importance is the magnetic load, which affects the velocity of the pulp and the recovery. Typically, a recovery of 51 per cent of the uranium was reduced to one of 40 per cent as the magnetic load was increased from 25 to 100 g/l, while the pulp velocity (calculated from the volumetric flow through the matrix and the cross-section of the matrix) decreased from 62 to 36 mm/s. There was some indication that, for the same pulp velocity, lower recoveries are obtained when free-fall feeding is used..

Recoveries are reduced when the magnet field current is reduced; each particle size is affected equally, so that the size–recovery distribution curves for high and low field strengths have a similar shape.

A reduction in recovery of 4 to 5 per cent was observed in a test simulating the effect of the air gaps in the magnetic circuit of a continuous separator.

Some benefit was observed in the application of WHIMS to coarsely ground ore; from a Blyvooruitzicht rod-mill product, 25 per cent of the total uranium was recovered when only 29 per cent of the rod-mill product (the finest portion) was treated. A similar recovery was made from 43 per cent of the rod-mill product from Stilfontein; a second stage of treatment after regrinding

raised the overall recovery of uranium to 76,4 per cent.

Recoveries of 55 and 42 per cent of the uranium were obtained in tests on two flotation tailings from Free State Geduld.

The application of WHIMS to the concentration of chromite in a sample from the UG-2 Reef did not yield an acceptable grade of magnetic product because of the similarity of the magnetic properties of the chromite and the pyroxenes.

In a determination of the mass magnetic susceptibilities of the constituents in a typical concentrate obtained by WHIMS, it was found that some 20 per cent of the magnetic product had a susceptibility of less than $5{,}4 \times 10^{-6}$ e.m.u. but contained 38 per cent of the uranium recovered by WHIMS.

A few tests were conducted on different types of matrix. Magnetic stainless-steel balls gave recoveries markedly lower than those obtainable with soft-iron balls; steel balls (said to contain 0,9 per cent carbon) gave recoveries of uranium slightly lower (about 8 per cent) than those obtainable with soft-iron balls. Other tests on various types of matrix were of a tentative nature and inconclusive. A matrix of spaced horizontal rods is recommended for possible future consideration.

Report no. 2083

The determination, by anodic-stripping voltammetry, of zinc and lead in six NIMROC reference samples.

Zinc and lead were determined by differential-pulse anodic-stripping voltammetry in the NIMROC reference materials and two certified samples of the United States Geological Survey (U.S.G.S.). The samples were dissolved in a 20:1 mixture of hydrofluoric and perchloric acids at room temperature or at 150°C in a Teflon-lined pressure vessel. The resulting solutions were taken to dryness and the residues dissolved in 8M hydrochloric acid.

Depending upon the concentrations of the interfering elements, zinc and lead were determined in an aliquot volume of solution directly after evaporation to dryness, or after the extraction of iron (III) into diisopropyl ether, or after the subsequent separation of zinc and lead into a mixture of triiso-octyl amine and xylene. The final electrolyte was a mixture of 0,1 M sodium acetate and 0,025 M potassium thiocyanate. The instrumental parameters were optimized, and the effects of the interfering elements were assessed.

The developed procedure as varied to suit the conditions yielded accurate values for zinc and lead in the two U.S.G.S. control samples.

Report no. 2086

An automatic sampling probe for use in the carbon-in-pulp process.

A description is given of a sampling system incorporating a probe for the continuous taking of filtrate direct from pulp in process streams. The filtrate is suitable for direct analysis by an analytical instrument such as an atomic-absorption spectrophotometer. The probe system delivers samples to the on-line analytical equipment with very little delay, and, because it is partly self-cleaning, it requires the minimum of maintenance.