# Coal – the No. 1 contender for the energy title (special report on the Witbank coal colloquium)

by J. E. FURZE*

World-wide hikes in the oil price and the prospect of future scarcities of liquid and gaseous fuels have given enhanced status to the South African coal industry. It is thus understandable that the colloquium held at Witbank on 3rd and 4th October, 1979, and organized jointly by the South African Institute of Mining and Metallurgy and the South African Coal Processing Society should have attracted more than 400 delegates. The colloquium†, which dealt with 'Mining methods and economics for improved coal extraction, and coal processing and preparation', was opened by the President of the South African Institute of Mining and Metallurgy, Mr D. A. Viljoen‡.

## Coal Extraction

This section of the colloquium was chaired by Mr G. G. Thompson, of General Mining and Finance Corp. Limited, and Mr D. Rankin, of Anglo American Corporation of S.A. Limited.

Mr P. King, former Director of Coal Mining Research and Development at the Chamber of Mines of South Africa, examined the coal reserves in South Africa and forecast the likely trends in mining methods.

From the 74 collieries in South Africa, 71 per cent of the South African coal is produced in the Transvaal and 90 per cent of the South African coal reserves are in that province. During the past ten years, and particularly since 1975, South African coal mining has become increasingly mechanized. Whilst pillar mining was once the most common mining method, recent coal mining expansions had used opencast mining.

King showed that, in due course, longwalling or panel mining would be the most widely adopted mining method for many new mines. In discussing the recovery factor or extraction ratio, King highlighted the necessity of seam stabilization, and expressed the view that the re-introduction of power-station fly-ash as a filler into the underground workings would probably provide the best stabilizing technique. Over 100 million tons of fly-ash have been dumped in the vicinity of collieries, and further ash is currently being produced at the rate of 10 million tons per annum. The storage of fly-ash in mine workings is currently being studied in South Africa.

Whilst the estimates of the South African coal reserves at 81,3 billion tons (gigatons) of '*in situ* mineable coal' and 25,3 billion tons of 'economically extractable coal' are still recognized as official, new mining and beneficiating techniques could lead to the adoption of higher reserve figures. The Petrick figures for coal reserves are based upon a 1972/73 estimate, upon a minimum thickness of coal seam of 1,2 m, and a maximum ash content of 50 per cent.

King stressed the long-term economic advantage of high-extraction working methods, which would prolong the life of the mine and so delay the need to establish a shaft elsewhere. (The current cost of establishing a colliery is at least R25 per annual ton.)

Selective utilization of coal reserves will allow optimum coal extraction, but, as in the case of 'tied' collieries, which constitute 59 per cent of the local coal production, this is not always possible.

In examining improved mining methods, Mr J. D. Inch, Project Manager of Bosjesspruit Colliery, reviewed the four main types of continuous miners used in South Africa. The borer, ripper, oscillating-head, and horizontal-drum types are all of American origin, and were designed essentially to operate in relatively soft bituminous coal. Problems eventually arose when continuous miners were used on the harder, more abrasive South African coal, and their successful application was achieved only during the past four years. Today drum miners are built in South Africa with a high local content.

Mr J. D. Stone, the Manager of Matla Coal Limited, highlighted factors (such as good service and spare-holding, and high local content to avoid dependence on foreign suppliers) as being important in the choice of continuous miners.

Stone had found that, because of the varying nature and hardness of coal in South Africa, recommendations from overseas had proved to be of little value — experience in South Africa had to be gained from tests conducted here.

Inch described how, to eliminate health hazards and improve visibility, water is infused into the coal face by means of special guns operating at a water pressure of 4 to 6 MPa. These are inserted into deep holes in the face, and allow water to travel down the coal seams.

Mr I. O. Brumby, the Manager of South Witbank Coal Mines Limited, described the experience at South Witbank since 1975 in the use of Joy 12 CM 6 rotary-drum continuous miners. He stated that, where special development or undermining work had to be done, these machines had proved to be a valuable asset. The production rates achieved to date had exceeded expectations, and world production records had been achieved at Phoenix Colliery and South Witbank. Although continuous miners had proved to be efficient and safe, he believed that much more experience had still to be gained in various operational aspects.

Pillar extraction at Usutu colliery was mentioned as

*Simon Carves (Africa) (Pty) Ltd, Randburg, Johannesburg.

†The titles of the papers presented at the colloquium are given on p. 495.

‡The text of Mr Viljoen's opening address is given on pp. 493-495.

an example of the unconventional use to which continuous miners could be put. Mr C. J. Beukes, General Manager of Usutu Colliery, described in detail the methods used,[1] and showed that operational costs are lower than with conventional bord-and-pillar mining techniques.

Beukes pointed out that goafing usually occurred about 30 minutes after the roof-support tinkering had been withdrawn. Machine breakdowns had to be kept to a minimum to prevent the continuous miner being trapped by fallen goaf. Breakdowns were kept to a minimum by checking and lubricating before each shift and by keeping minor spares underground.

Mr P. G. Henderson, of General Mining Coal Division, described the vertical longwall operations at Coalbrook Collieries. The problems encountered there included strata control, support, stone intrusions, and the inflow of a goaf and water between the face supports and onto the face. Nevertheless, during the production of 2 million tons over the past three and a half years, satisfactory solutions had been evolved for these problems, and it was envisaged that longwalling would become the most economic method of coal extraction and safer roof control at Coalbrook. In extracting this O.F.S. coal, which has an average calorific value of between 16 and 19 MJ/kg, Coalbrook had had to learn the hard way, but a production rate of 100 000 tons per month could be expected with a second longwall installation.

The longwalling experience gained at Coalbrook would provide excellent 'in-company' training and cost information for the much larger-scale coal-mining operation at Matla Coal.

Mr C. J. Cloete, Manager of Sigma Colliery (Sasol I), commenting on Henderson's paper, stated that conditions and equipment in the longwalling of No. 3 seam at Sigma differed considerably from those at Coalbrook, where the seams being longwalled are No. 1 and 2 coal seams.

Cloete stressed that, with the introduction of longwalling at Sigma, it was realized that production would follow the normal learning curve. A weekly production of 40 000 tons had now been achieved.

Whereas the failure or poor performance of men or machines did not necessarily bring mining operations to a standstill when conventional methods were used, these could sometimes result in a complete stoppage of work with longwalling. Both Henderson and Cloete stressed the need for good training and machine service.

In summarizing the coal-mining activities in South Africa, the meeting stressed that newer coal-mining techniques and expanded geological exploration in South Africa would probably increase the reserves established by the Petrick Commission from 23 billion tons of economically extractable coal to about 61 billion tons. Much stress had recently been placed on opencast expansions; this type of mining now accounts for approximately 20 per cent of all coal production.

Fine coal (smaller than 0,5 mm) is being dumped at present, but could be utilized by power stations. The development of Coalplex-type operations, which are capable of accepting all types of coal, would have a major effect upon the future utilization of reserves.

Studies had shown that, despite the increase in relative importance of opencast and longwall mining methods, bord-and-pillar mining was likely to remain for many years the most important method of coal extraction.

Dr H. Wagner, of the Chamber of Mines Research Laboratories, discussed the efficiency of coal extraction in relation to seam height, pillar centre distances, and depth of mining. He described the existing design methods for bord-and-pillar workings in South Africa, and highlighted new developments and some of the more intricate problems.

Mr I. Buchan, of Anglo Power Colliery (Kriel Division), discussed opencast coal mining at Kriel, making particular reference to the water problem encountered there and the operation of the draglines on sloping ground to a depth of 40 metres to the top of the coal seam. A small stream had been diverted over the no-coal areas, and to prevent excessive erosion gabions had been constructed from local stone.

Mr M. F. Pleming, Manager (E. Transvaal) of General Mining Coal Division, supplied a written contribution about opencast coal mining. This contribution covered restoration of the surface of the completed opencast operations at Optimum Colliery, and outlined the fuel-conservation efforts being made there. It was of vital importance that the high usage of diesel fuel (1,3 litres per ton of coal mined) in opencast mining operations should be reduced. Unless a solution was found soon, the advantages that had prompted opencast mining operations would be seriously questioned.

Turning to export-handling facilities, Mr Makin, of the Richards Bay Coal Terminal, amplified the paper written by Mr M. B. Dunn by presenting a series of slides and outlining the developments planned at Richards Bay.

With an original export target of 12 million tons per annum in 1976, the terminal had now been expanded to 24 million tons per annum, and plans were already far advanced to expand the terminal to 44 million tons per annum by 1983/85. The terminal provided a valuable buffer link between the mines and the consumer. With an average storage capacity of approximately 10 per cent of the annual quantity handled, the terminal cost was relatively low, amounting to 7 per cent of the c.i.f. coal cost.

With modern bulk carriers costing 10 000 to 30 000 U.S. dollars per day, proper project planning was essential to prevent costly plant disruptions. This bold venture, first investigated in 1961, was likely to be ultimately handling some 90 million tons per annum, and would ensure a healthy export revenue to South Africa.

## Coal Processing

The session Chairmen, Mr J. Shilling (Chairman of the Coal Processing Society) and Dr A. Brink (Sasol) introduced a wide range of speakers on coal benefication and special applications.

Mr D. W. Horsfall, Consulting Metallurgist of Anglo American's Coal Division and a leading figure in the Coal Processing Society, presented a comprehensive history

of coal preparation, paying particular attention to new developments in coal preparation. Horsfall stressed that, since coal is South Africa's only substantial source of fossil fuel, we should optimize the various grades by reserving high grades for petro, refining, and metallurgical coking uses.

Mr P. J. F. Fourie, of the Fuel Research Institute, expressed the opinion that coal-washery performance tests should be conducted at more frequent intervals in order to prevent the dumping of off-grade coal. Fourie noted that the efficiency of a coal-preparation plant is directly related to the attitude and knowledge of the plant managers and superintendents. He believed that better training of staff in coal washing would improve the efficiency.

Mr P. Armstrong, of General Mining and Finance Corporation Limited, pointed out that a high proportion of fine coal (of a particle size smaller than 0,5 mm) with a high ash content could be expected in run-of-mine ore in the future. He believed that this fraction could be beneficiated by froth flotation, a technique that had rarely been used in coal plants ten years ago.

The work described in Armstrong's paper was aimed at the production both of low-ash coals suitable for metallurgical use and of coals with reasonably high calorific values suitable for export as steam-raising coal. On coal-flotation plants in the Transvaal and Natal, preference was being given to the use of non-kerosene based flotation reagents.

Mr T. A. Claasen, of Iscor, outlined the depletion and scarcity of metallurgical coal required by Iscor, and described the coal-preparation routes being investigated to produce suitable metallurgical coal with an ash content of 12 per cent and a moisture content of less than 8 per cent. It was found that, to achieve maximum recovery, the preparation route would need to produce very fine coal, which had previously been discarded. Laboratory tests on the flotation of this fraction had been encouraging, but the associated problem of final moisture removal needed attention. Centrifugal separation of the 0,5 mm fraction could result in a moisture content of 15 per cent, but the very fine fractions would have to be dewatered by filtration (perhaps with the addition of filter aids such as oil to the slurry), briquetting, and drying of the product in suitable furnaces.

Regarding discard material, Mr R. B. MacGillivray, of Rand Mines, outlined an imaginative plan to utilize the annual 9 million tons of colliery discard in the Witbank–Bethal areas. This coal has a calorific value of between 9 and 18 MJ/kg and, if utilized, could fuel a 1200 MW power station. The MacGillivray plan is to interconnect 19 collieries with conveyors terminating at a central power station, where there would be a fluidized combustion boiler. MacGillivray argued that sulphur was at present being randomly discharged as sulphur dioxide into the atmosphere from discard dumps all over the area, and, if the coal were treated with limestone before burning in the boiler, this atmospheric pollution could be considerably reduced. The use of one central boiler instead of smaller boilers at each mine would considerably reduced the costly water-treatment circuit needed for any power station.

MacGillivray estimated that the scheme envisaged would result in a revenue from coal sales of R40 million per annum for the Witbank area. He estimated the capital cost of conveyors at R25 million, while the cost of road/rail/river crossings would be about R31 million. He proposed that these latter costs should be financed by individual collieries, and that Escom should finance and operate the central power station in the same manner as conventional power stations. The calculated return on the capital invested for each mine would vary, but would average 108 per cent.

These estimates were based on the assumption that fluidized-bed boilers of sufficient size would be available in three to five years. Gasification or liquifaction might equally be found to be a suitable solution for the utilization of discard colliery material. A complete assessment would need to include the utilization of pulverized fuel ash, and this was still to be studied.

Mr T. D. Cruikshanks, of Babcock & Wilcox Africa, delivered a paper written by Mr E. A. Glaysher, of Fluidized Combustion Contractors Ltd. This paper described fluidized-bed boilers of both the atmospheric-pressure type suitable for evaporating up to 230 tons per hour, and the pressurized type now being developed for power generation. Since the combustion temperature is lower than in conventional firing systems, it is expected that NOX figures would be well within the allowable limit of atmospheric pollution. Cruikshank showed that a fluidized-bed boiler would be smaller than the conventional power-station boiler, but its development would probably be retarded by reluctance on the part of potential users to become pioneers in this new technology.

The importance of metallurgical coke for the production of char, which is used as a reducing agent in the electro-metallurgical industry producing ferrochromium and other ferro-alloys, was emphasized by Mr E. F. E. Müller, of the Fuel Research Institute. This Institute is fully organized to conduct char tests, and its personnel continuously study world trends in char production. Char, as opposed to coke, has to be produced from coal that does not soften, become plastic, and swell during heating in the absence of air or in the presence of only a limited air supply. The 5 t/d rotary carbonizer at the Fuel Research Institute is the only one of its kind in the world, and contract work is undertaken for both local and overseas clients.

Since char is used in submerged-arc furnaces, a study of the factors affecting the resistivity and reactivity of chars for the electric-smelting industry formed part of a detailed study undertaken at the National Institute for Metallurgy. Mr D. J. Smith, discussing some of the results obtained, explained that the resistivity of char produced from a coal under reducing conditions was usually higher than that produced under oxidizing conditions. However, this effect was not as great as an increase in the charring temperature, which resulted in a significant decrease in resistivity and an increase in the fixed carbon. High resistivity of the burden could be expected if the particle size of the reducing agent were large in relation to the other components charged into the furnace. On the other hand, reducing

agents having a large volume fraction in the burden tended to have higher reactivity towards chromite ore in the liquid state, and towards manganese ore in the solid or liquid state.

### Social Aspects

Thanks to the generosity of Amcoal, Joy Manufacturing, Envirotech, Ore Sorters, and Highveld Steel & Vanadium, the socal aspects of the conference were well taken care of, and provided an excellent opportunity for an informal interchange of knowledge and ideas among delegates, organizers, and those involved in the coal-related industries.

# Company Affiliates

The following members have been admitted to the Institute as Company Affiliates.

AECI Limited.
Airco Engineering (Pty.) Limited.
Amalgamated Collieries of S.A. Ltd.
Apex Mines Limited.
Associated Manganese Mines of S.A. Ltd.
Blackwood Hodge (S.A.) (Pty.) Ltd.
Blyvooruitzicht Gold Mining Co. Ltd.
Boart International Limited.
Bracken Mines Ltd.
Buffelsfontein Gold Mining Co. Ltd.
Compair S.A. (Pty.) Limited.
Consolidated Murchison (Tvl.) Goldfields & Development Co. Ltd.
Deelkraal Gold Mining Co. Ltd.
Delfos & Atlas Copco (Pty.) Ltd.
Doornfontein Gold Mining Co. Ltd.
Dowson & Dobson (Pty.) Ltd.
Durban Roodepoort Deep Ltd.
East Driefontein Gold Mining Co. Ltd.
East Rand Proprietary Mines Limited.
Eimco (Pty.) Limited.
Engineering Management Services (Pty.) Ltd.
Envirotech (Pty.) Ltd.
Free State Saaiplaas Gold Mining Co. Limited.
Gardner-Denver Company Africa (Pty.) Ltd.
Gold Fields of South Africa Limited.
The Griqualand Exploration & Finance Co. Ltd.
The Grootvlei (Pty.) Mines Ltd.
Harmony Gold Mining Co. Ltd.
Hartebeesfontein Gold Mining Co. Ltd.
H. Heimscheidt Mining & Hydraulic Equipment S.A. (Pty.) Ltd.
H.L. & H. Mining (Pty.) Ltd.
Highveld Steel & Vanadium Corp. Ltd.
Hubert Davies Heavy Equipment (Pty.) Ltd.
Impala Platinum Limited.
Ingersoll Rand Company S.A. (Pty.) Ltd.
Johannesburg Consolidated Investment Co.
Kinross Mines Limited.
Kloof Gold Mining Co. Ltd.
Lenning Holdings Limited.
Leslie Gold Mines Limited.
Libanon Gold Mining Co. Ltd.
Lonrho South Africa Limited.
Loraine Gold Mines Ltd.
Marievale Consolidated Mines Limited.
Matthey Rustenburg Refiners (Rustenburg) (Pty.) Ltd.
The Messina (Tvl.) Development Co. Ltd.
Mitchell Cotts Projects S.A. (Pty.) Ltd.
Montan Chemicals (Pty.) Ltd.
Natal Cambrian Collieries Limited.
The Northern Lime Co. Ltd.
O'Okiep Copper Co. Ltd.
Palabora Mining Co. Ltd.
Photometric Sorters.
President Steyn Gold Mining Co. Ltd.
Pretoria Portland Cement Co. Ltd.
Prieska Copper Mines (Pty.) Limited.
Rand Mines Limited.
The Randfontein Estates Gold Mining Company Witwatersrand Ltd.
Rooiberg Minerals Development Co. Ltd.
The Robbins Co. (Africa) (Pty.) Ltd.
Rustenburg Platinum Mines Ltd. — Union Section.
Rustenburg Platinum Mines Ltd. — Rustenburg Section.
Shaft Sinkers (Pty.) Ltd.
S.A. Cyanamid (Pty.) Ltd.
R. J. Spargo Limited.
St. Helena Gold Mines Limited.
Senmin (Pty.) Limited.
Shell South Africa (Pty.) Ltd.
Southern Prospecting (Pty.) Limited.
Steel Engineering Co. Ltd.
Stilfontein Gold Mining Co. Ltd.
T. H. Mining Supplies (Pty.) Ltd.
Transvaal Consolidated Land & Exploration Co.
Trans-Natal Coal Corporation Limited.
Tsumeb Corporation Limited.
Union Corporation Limited.
Vaal-Reefs Exploration & Mining Co. Ltd.
Venterspost Gold Mining Co. Ltd.
Vergenoeg Mining Co. (Pty.) Ltd.
Welkom Gold Mining Co. Ltd.
West Driefontein Gold Mining Co. Ltd.
Western Areas Gold Mining Co. Ltd.
Western Deep Levels Ltd.
Western Holdings Limited.
Winkelhaak Mines Limited.