Coal and coal preparation in South Africa—A 2002 review

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Synopsis

The design and operation of coal preparation plants are governed by the inherent quality of the raw coal to be processed, market specifications and the saleable tonnage requirements. Topography influences the layout of the plant but does not affect the process design.

The coal market comprises many sectors, each having specific requirements with respect to both size and quality. In turn, these have led to different levels of preparation and the development of specific types of coal preparation plant design.

Developments in processing techniques and processing equipment have also influenced the design and now give the preparation engineer numerous permutations in process and equipment selection.

This paper gives an overview of the coal industry in general and summarizes some of the developments in the design of plants and technical developments in the areas of dense medium processing, fine coal treatment and equipment design.

Introduction

This paper gives a synoptic review of the developments in coal preparation practice in South Africa over the last quarter of a century. The review is not intended to be exhaustive but to focus on those aspects of development which, in the author's opinion, have played a significant role in enhancing the practice of coal preparation.

The coal industry has grown at a phenomenal rate over the last 35 years, with saleable coal production increasing from 50 million tonnes (Mt) in 1968 to 227 Mt in 2001 (295 Mt Run of Mine) at an average compound growth rate of 5% per annum or an increase of 5.3 Mt/annum. This growth, coupled with changes in both local and export markets, has resulted in many developments in coal preparation technology.

The XIV International Coal Preparation Congress was held in South Africa in March 2002 and the papers presented there provided a rich source of information. The paper also includes discussions on matters of a more general nature which affect the coal industry at large and are of specific interest.

The views expressed in this paper are those of the author and do not necessarily represent those of any other party.

Historical perspective

Coal has been used by man for a thousand years as a source of fuel for domestic heating and cooking and as a source of heat for hot metal forging. The industrial revolution in Europe in the 18th and 19th centuries saw the development of the Bessemer furnace for the reduction of iron ore and the steam engine for the production of power, and heralded the coal age. The golden era for coal lasted well into the 20th century before being surpassed by cheap oil, natural gas and nuclear power.

In South Africa, the first recorded discovery of coal was in 1699 at Fransch-Hoek in the Western Cape. It is probable that the indigenous inhabitants of South Africa exploited some of the easily accessible coal reserves before the arrival of European settlers in the interior of the country, but little trace of this has been found.

The earliest recorded exploitation of coal was in the Molteno-Indwe field (in the Eastern Cape) in the early 1860s and in Natal in the late 1860s.

It was with the discovery of the Kimberley diamond fields in the 1870s and the Witwatersrand gold fields ten years later that the development of coal mines as a fuel supply to the mines became imperative, leading to the development of coal mines near Vereeniging, on the East Rand and in northern Natal.

The first coal mines opened were:

- Molteno 1864
- Talana 1865
- Vereeniging (Maccauvlei, Bedford) 1880
- Boksburg, Brakpan 1888

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- Dundee, Klip River (Natal) 1888
- Cassel (Springs) 1892
- Newcastle 1895
- Douglas, Transvaal and Delagoa Bay, Landau 1897.

The discovery of gold on the Wiwatersrand was closely followed by the discovery of coal in Boksburg in 1887. The vast Witbank coalfield was developed in the 1890s and became the principal source of power for the country's industries, mines and rail system. As the gold industry burgeoned, the demand for power increased and this prompted the development of the major coal industry in the Eastern Transvaal, now named Mpumalanga, to supply the growing number and size of power stations.

The successful development of coal synthesis technology saw the first oil from coal produced in South Africa at Sasolburg in 1955. The 1973 oil crisis and the need for an adequate supply base of transport fuel gave impetus to the further development by Sasol at Secunda where four coal mines initially fed the Sasol 2 and Sasol 3 plants at a rate of 29 million tonnes per annum (Mt/a). Currently six coal mines supply Sasol at a rate of 49.5 Mt/a with a washed coal fraction being produced for export.

The developments spawned by the same oil crisis, together with the low ash contract between the Transvaal Coal Owners Association and the Japanese Steel Mills, resulted in the export boom during the late 1970s. In 1975 South Africa only exported about 2 million tonnes of coal. In the 1970s, in a remarkable partnership between private coal companies and the State controlled railway and harbour administration, the port of Richards Bay was developed as a specialist deep water bulk export port, and the coal companies, through the Transvaal Coal Owners Association, combined to build the Richards Bay Coal Terminal (RBCT).

RBCT was initially designed to handle 12 Mt/a and was expanded in several phases to 24 Mt/a, 44 Mt/a, 53 Mt/a, and 67 Mt/a, with a current design capacity of 72 Mt/a. The rise in exports, of which the majority is washed coal, has been the driving force behind the development of coal preparation technology in the country. The five great South African Mining Houses (Anglo American, Gencor, Gold Fields, JCI, Rand Coal) together with Lonhro (Duiker Mining) formed the backbone of the TCOA in 1975. Of these, only three remain, Anglo Coal, Ingwe (Billiton) and Duiker Mining (Xstrata), the remainder having been taken over by these three in a major rationalization of the industry during the 1990s.

The Iron and Steel Corporation's (Iscor) need for coking coal led to major developments in the Natal coalfields (now all closed) and more recently the Waterberg Basin. The largest beneficiation plant in the world is at Grootegeluk. The plant was commissioned in 1980 to supply 2 Mt/a of coking coal at 12.5% yield for Iscor and 4 Mt/a of steam coal at 25.3% yield for Eskom's Matimba Power Station. The mine capacity has been expanded over the years and 16 Mt/a of sales are currently produced comprising 13 Mt/a thermal, 2 Mt/a coking and 1Mt/a metallurgical coal. The coal preparation plant treats 32 Mt/a of run of mine coal at a rated throughput of 6000 t/h.

In 1987 there were 104 operating coal mines and there are now only 73. Many of the smaller operations have been mined out and closed down and fewer mines of larger capacity have been opened to fuel the demand for exports and local consumption.

The growth of the coal industry is reflected in Table I.

There have been several major changes in the pattern of coal utilization over the years, as shown in Table II.

The figures given for the historical production of coal are coal sales figures. The major market sectors are:

- Electricity
- Exports
- Synfuels.

South African coal industry in 2002

Two giants of the local coal industry are Anglo Coal and Ingwe (a subsidiary of BHP Billiton), both companies holding

Table I

RSA coal sales production

Year	Mt	Year	Mt	Year	Mt
1966	46.92	1978	85.69	1990	184.45
1967	48.33	1979	98.22	1991	181.90
1968	50.56	1980	113.08	1992	179.22
1969	51.20	1981	129.91	1993	184.00
1970	53.12	1982	140.33	1994	193.66
1971	56.98	1983	144.61	1995	206.1
1972	57.19	1984	161.32	1996	206.36
1973	61.55	1985	172.00	1997	221.64
1974	64.63	1986	176.21	1998	224.21
1975	69.12	1987	172.57	1999	220.44
1976	75.72	1988	183.61	2000	225.83
1977	85.00	1989	179.92	2001	227.51

Table II

Coal supply to market sectors

Sector	1927		1939		1951		1995		2001	
	Mt	%	Mt	%	Mt	%	Mt	%	Mt	%
Exports	3.6	27	2.3	13	2.2	8	55.3	27	69	31.2
Railways	3.2	24	3.9	21	5.9	20	0	0	0	0
Electricity	2.7	20	5.8	32	10.4	36	82.4	41	89	40.3
Mining	2.1	16	2.4	13	2.8	10	0	0	0	0
Industry	0.4	3	1.1	6	1.4	5	5.5	3	5.8	2.6
Synfuels	0	0	0	0	0	0	43.4	21	48	21.7
Metallurgical	0.3	2	0.8	4	2.2	8	7.3	4	5.5	2.5
Domestic	1.0	8	2.0	11	4.0	13	8.3	4	3.7	1.7
Total	13.3	100	18.2	100	28.8	100	202.2	100	221	100

very large sales contracts with Eskom, with concomitant secured sales (about 40 Mt/a each) and profitability. Ingwe holds the largest share in RBCT (±40%), while Anglo Coal's share is about 27%. Both Anglo Coal and Ingwe are components of giant international corporations, with major shares in the coal industry in Colombia, Australia and South Africa, and significant market shares in the international coal trade.

Following its acquisition of the Tavistock operations in 1998, Duiker moved into third place in the coal league, with annual sales of about 13 Mt, but no long-term position with Eskom. Duiker also disposed of its anthracite business (less than 1 Mt/a) in 1999. Duiker became a subsidiary of Glencore, the international trading company, in 2000 and in 2002 it became a wholly owned subsidiary of Xstrata, the London listed mining company. At the same time, Xstrata acquired the other Glencore coal assets, which makes it a part of the international triumvirate that, together with Anglo Coal and BHP Billiton, dominates the international coal industry.

Two other major producers are Kumba Resources and Sasol Mining, although by far the majority of coal mined by these companies is for local consumption. Kumba was previously the mining arm of Iscor, which split into a resources and mining company (Kumba) and an iron and steel producer (Iscor Steel), both independently listed. Sasol Mining is the coal mining subsidiary of Sasol Limited, a giant oil and chemicals producer with international interests. Both Kumba and Sasol Mining export small tonnages of coal, and Kumba will participate in RBCT through the next phase expansion.

New black empowerment mining groups have been created in the last three years. The major group is Eyesizwe, which took over four collieries from Anglo Coal and Ingwe and produces 19.5 Mt/a sales. There are now 16 black empowerment registered operating groups.

In addition to the big participants, there are very many small producers and traders operating in South Africa, mostly dealing only in the local market, but several companies supply coal on a traded basis to existing exporters, while others trade for their own account, exporting through Maputo and Durban.

Of these, the more important are:

- Imbani/Carolina Coal Company—Markets ± 0.7 Mt/a from its own mines in the Carolina district, mostly through Maputo. Controls Carolina siding
- AfriOre—Anthracite producer in Natal
- SA Carbon—Anthracite producer in Natal with undeveloped bituminous coal reserves in Mpumalanga
- Coal Procurement—Coal trader and exporter with established links to producers and markets. Handles ± 1.0 Mt/a, mostly through Durban.

The mining houses have restructured with smaller corporate head offices and fewer staff. Many head office consultants in coal preparation have taken early retirement or redundancy packages. Most are now working as independent consultants, in some cases with their original employers, or with suppliers and contractor organizations. Mining houses are increasingly outsourcing their technical requirements and retaining only minimum core competencies at head office with many responsibilities now being delegated to the mines. This in itself gives rise to opportunities for consultants, contractors and suppliers, as the mines are not always geared or trained to handle the additional workload placed upon them.

Of the 295 Mt/a of raw coal currently mined, coal from open pit operations makes up 30% of the total. Most of this tonnage is derived from dragline stripping operations. There is one major open pit operation using truck and shovel and several small operations also using this technique.

Coal in South Africa is relatively shallow, with most underground operations being bord and pillar, the majority of which use continuous miners with others using conventional drill and blast methods. Longwall mining contributes only a small percentage of underground production due to:

- The high extraction rates that are achieved with bord and pillar mining as a result of depth
- The high percentage of intra-seam sandstone inclusions
- The significant level of igneous intrusions within the coalfields.

The majority of South African coal production is medium volatile (22–26%) bituminous coal with relatively low sulphur (<1.3% unwashed or < 0.8% washed).

There are small quantities (<3%) of coking coal and anthracite (<2%) produced.

Coal for electricity generation is generally unwashed, whereas coal for local trade and exports is beneficiated with an average yield of 60–65% and a calorific value (CV) of ± 28 MJ/kg, air dried.

The South African coal industry relies heavily on its exports. RBCT is a private initiative, controlled by its shareholders (Figure 1), and only shareholders in the terminal may use the facility. It will be readily appreciated that, with total exports of about 72 Mt/a and total RBCT throughput of about 68 Mt/a, access to RBCT capacity is the strategic key to participation in the coal export business in South Africa. Four other alternative facilities exist:

- Matola terminal in Maputo
- McMyler appliance in Maputo
- Bluff appliance in Durban
- General crane berth in Durban.

There is also a possibility that Portnet may open a container terminal for coal at Richards Bay.

In 2001, about 1.3 Mt was exported through Maputo and about 2.25 Mt through Durban. The costs of these alternative facilities greatly exceed the cost of RBCT, both in rail tariff and port charges. Moreover, only RBCT can cope with the large cape size vessels, leading to a substantial freight differential being applied.

At the time of the development of RBCT, the rail administration (now Spoornet), built a dedicated export line linking the major coal fields with RBCT, currently capable of handling several 200 truck trains of 16 kt capacity each day, while trains to the other ports are considerably smaller and fewer (Maputo trains are restricted to 1 200 tonnes and only about 6 are allocated in a day). Consideration is being given to the expansion of the coal lines to include the Waterberg coalfield and the upgrading of the Maputo line as part of the Corridor development. If this is done, and if modest further investment is made at the Matola terminal (new stockyard,

second ship-loader, barges for panamax loading), it is estimated that Matola could cope with annual exports of 5–8 Mt.

It was recently announced that the South Dunes Coal Terminal project for the development of a new terminal at Richards Bay would not proceed and that instead the SDCT would participate in a final expansion of RBCT from a design capacity of 72 Mt/a to 82 Mt/a. Of this increase of 10 Mt/a, 6.5 Mt/a would be allocated to the SDCT for use by its participants and 3.5 Mt/a would be taken up by the existing RBCT members other than Anglo Coal and Ingwe. The current and future shares in capacity are set out in Figures 1 and 2.

Employment in the coal sector

Average annual employment in the coal industry is given in Table III.

It should be noted that much of the reduction in staffing can be attributed to a general move by employers to the employment of contractors ('outsourcing'), especially in so-called non-core activities.

Coal geology and reserves

In South Africa, coal occurs in the Ecca series of the Karoo system, with deposition taking place in the Permian period, 150–200 million years ago. The Karoo rocks cover a considerable area of South Africa and several distinct coalfields can be identified, as shown on Figure 3. It will be noted that the overwhelming majority of coal produced in South Africa emanates from the Mpumalanga province, with the Witbank, Highveld and Eastern Transvaal coalfields contributing almost 80% of current production. The most recent authoritative determination of coal resources in South Africa took place in 1987 when it was estimated that 55.3 billion tonnes of extractable coal existed. In this report, the reserve of high grade, non-coking bituminous coal was estimated at about 7 billion tonnes, the largest block being within the Witbank field.

Coal qualities vary widely across the various coalfields, with some resources being of such low quality (low CV, high ash) that they are used exclusively for local power generation by Eskom, which has pioneered the design of boilers to cope with such fuel. For example, the Lethabo power station south

Table III

Year	Employment
1990	84 000
1991	73 000
1992	75 000
1993	60 000
1994	58 000
1995	60 000
1996	61 000

User	Share %	Capacity Mt/a
AngloCoal	27.5	19.8
Duiker	21.0	15.1
Eyesizwe	1.3	0.9
Ingwe	37.4	26.9
Kangra	2.4	1.7
Sasol	5.0	3.6
Total Fino	5.6	4.0
Total	100.0	72.0

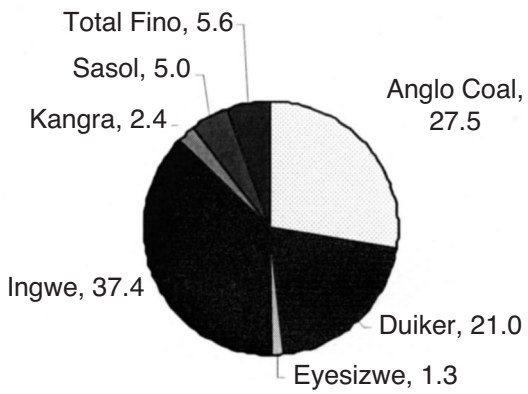

Figure 1—Current RBCT shareholding and capacity

User	Share %	Capacity Mt/a
AngloCoal	24.1	19.8
Duiker	20.9	17.1
Eyesizwe	1.2	1.0
Ingwe	32.8	26.9
Kangra	2.3	1.9
Sasol	5.0	4.1
Total Fino	5.7	4.7
SDCT	5.7	6.5
Total	100.0	82.0

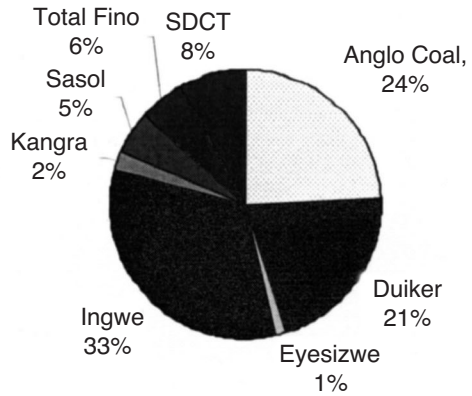

Figure 2—Future RBCT shareholding and capacity (after SDCT expansion)

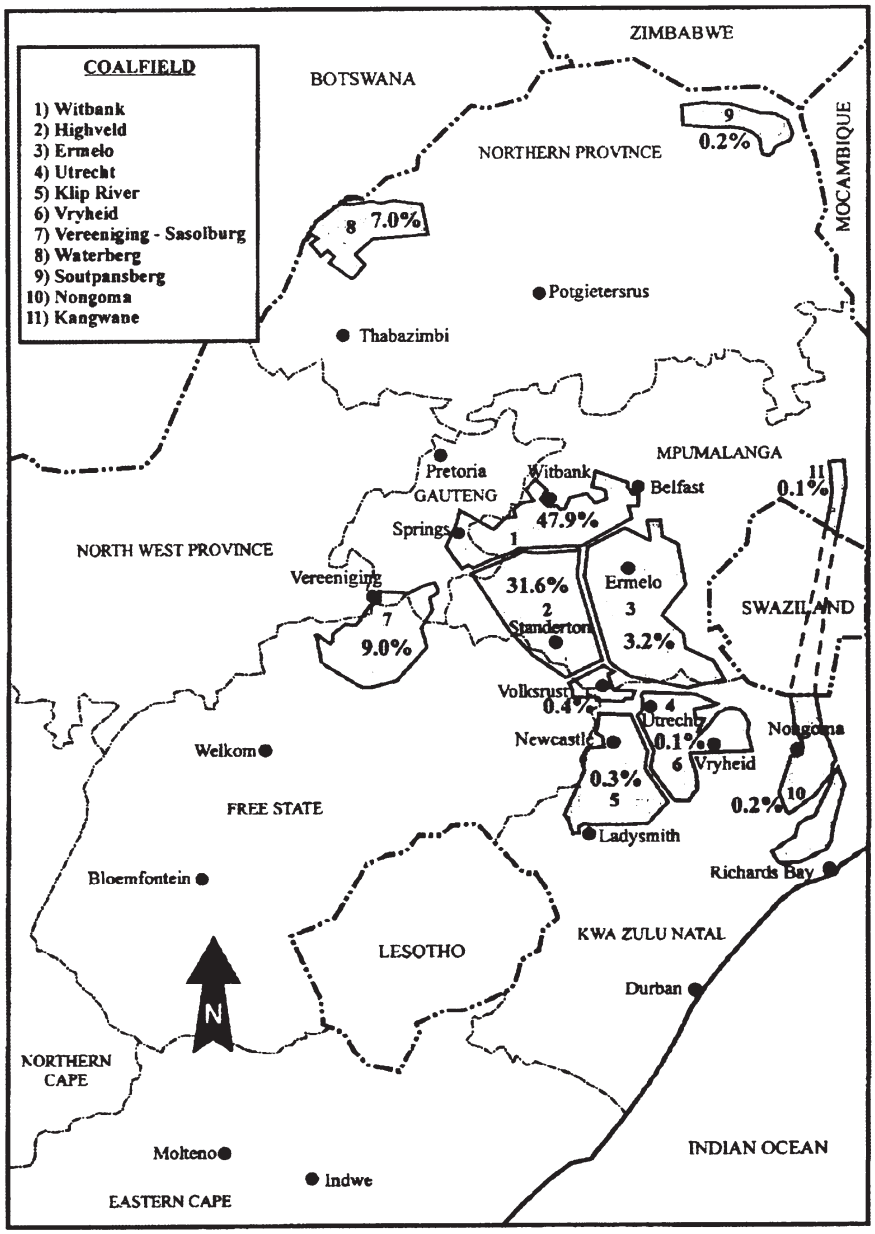

Figure 3—Distribution of South African coalfields and reserves

of Vereeniging burns coal with an ash content of ± 35% and CV of about 4 500 kcal/kg. Anthracite and anthracitic coals are mined in Natal, while soft coking coal is mined in the Northern Province (Tshikondeni and Grootegeluk).

Generally speaking, geological conditions are favourable for mining, especially in the Witbank coalfield, with thick, flat seams at reasonably shallow depths. This led to the development of several very large opencast mines as dedicated export producers (Optimum, Rietspruit, Middelburg, Kleinkopje, Atcom etc.), some of which have reached or are close to the end of their working lives. Other mines, both opencast and underground, provide coal on a dedicated basis to Eskom, the giant power utility and yet others to the local domestic markets.

Currently, the coal industry is facing certain critical decisions. The Witbank coalfield has been exploited for upward of a hundred years and many of the mines are coming to the end of their economic lives. While certain green-field opportunities still exist (Wonderfontein, Goedgevonden), in general the mining companies are facing the need to develop new mines in more distant coalfields such as the Waterberg, or smaller mines in traditional areas. This may change the economics of coal production in South Africa

Environmental framework

Each existing and new mine in South Africa (as well as any prospecting operation) has to submit a programme to the authorities in which the proponent demonstrates that it has understood the impacts of its activities on the environment and in which it demonstrates the way in which it will manage these impacts. If this programme is acceptable to the authorities, then they will issue a mining authorization and

the company can proceed to mine and rehabilitate the land. If all the commitments are fulfilled, the authorities will issue a closure certificate once these operations are completed, which absolves the operator from future liability.

The importance of mining to South Africa in terms of the income generated has always been recognized in law as the state encourages the exploration and exploitation of the country's mineral wealth. Environmental considerations are becoming more important, but do little to detract from exploitation on purely economic grounds. The cost of environmental issues remains a small fraction of total costs for most operations. Generally, the only impact on a project may be some delays due to the consultation and permitting processes, but this period often allows mining companies to refine their planning for new operations.

Key stakeholders

Coal companies

The principal coal companies have been described above.

Consumers and importers

By far the biggest consumer is Eskom, the South African electricity producer. The electricity sector consumed 89 million tonnes in 2001.

The major markets for South African exports are power utilities around the world. The major countries that import South African coal are:

- European Union 69.4%
- Far East 11.8%
- Middle East 10.5%
- Americas 2.8%
- Africa 5.5%

Sasol mines coal for its own use in the production of synfuels and chemicals, while Kumba does the same for Iscor for the production of steel (Iscor is also an importer of coking coal).

Additional major local consumers are:

- Sappi and Mondi (Paper industry)
- S.A. Breweries
- AECI (Chemical industry)
- Assmang and Samancor Ferroalloys (Ferro-metal production)
- Highveld Steel.

Coal is still used by a significant portion of the population as a fuel for cooking and as a source of home heating.

Unions

The major union operating in the coal sector is the National Union of Mineworkers (NUM). Other unions that are active are the Chemical Workers Union (CWU), the United Workers Union of South Africa (UWUSA) and the Mine Workers Union (MWU). There are, in addition, various other small unions.

More than 90% of the labour force is unionized, although no closed shop practice exists. It is difficult to gauge the extent of unionization within the small producers and the contract miners.

Wage negotiations take place yearly, either at mine level or through the Chamber of Mines for those companies that use the collective bargaining approach. There is an established legal framework that governs labour relations, conditions of employment negotiations and industrial action. In recent years the industrial climate has been reasonably peaceful, with mature attitudes being shown by both management and labour unions in the negotiating process.

Transport

The major transporter of coal is Spoornet, the State controlled rail network. There are numerous privately owned road transporters.

Local communities

Historically, South African mining companies supplied housing at nominal rentals to its white employees and accommodation to its migrant labour (essentially its black employees). In the seventies this started to change with housing being supplied across the board within the coal companies. Over the last ten years there has been a move away from this 'company housing' philosophy. What this means is that the term 'local communities' means different things at different mines. This includes:

- The community living in company housing
- The community that has bought previously owned company housing
- The community where the employee receives a salary with no other benefits i.e. the so called 'gate wage'.

Coal pricing

Coal pricing is not regulated by the State in South Africa.

Export pricing is determined largely in the competitive framework that exists among the major exporters (South Africa, Australia, Indonesia, Venezuela, Colombia) in among the various markets (Pacific Rim or Europe, steam coal or metallurgical coal). In specific cases, the logistics of coal export help to determine coal prices as, for example, for coal delivered to the west coast of India, which can only be done in small vessels, thus eliminating the normal freight advantage of exports through RBCT. For this reason, exports through Maputo are competitive with RBCT exports, since the landed prices are higher than would be the case if large vessels (panamax or cape size) could be chartered.

Inland pricing for normal consumers is likewise determined on a supply and demand basis, while special arrangements exist for coal supply to Eskom power stations where, as a rule, captive collieries have long-term contracts with particular pricing provisions.

Plant activity

There has been a limited amount of construction activity for new plants in the last three years. Several coal mines are coming to the end of their reserve life and are closing down, the more important being:

- Ingwe/Xstrata has announced the closure of Rietspruit. (Production 4.6 Mt/a in 2001).

- Ingwe announced the closure of Blinkpan, a section of Koornfontein Mine
- Duiker closed the South Witbank Coal Mine in 1999 and Arthur Taylor Colliery No. 2 Plant in 2002. (South Witbank has since re-opened)
- Kumba Resources finally closed Durnacol in KwaZulu-Natal.

Many smaller operating sections have been closed down and replaced by other small reserves.

On the brighter side, the number of mines in 2001 is reported to have increased from 74 to 77.

- Anglo Coal has opened the Nooitgedacht Colliery in the Witbank Coalfield
- Duiker has re-opened South Witbank Coal Mine. The plant has been rebuilt with 4 cyclone modules (800 mm dia) each nominally rated at 200 t/h.

New mines/plants in the planning stage include:

- AfriOre's Somkele Colliery in KwaZulu-Natal. (Heavy media drum and cyclone plant producing 0.5 Mt/a sales of anthracite)
- Kumba Resources are planning a 1 Mt/a export quality mine at Kalbasfontein in the Witbank area
- TotalFinaElf are planning on doubling their operation at Forzando Colliery with the installation of a second dense medium cyclone and spiral plant
- Ingwe's new mine and plant at Klipspruit Colliery
- Duiker has a project planned for Goedgevonden near Ogies in the Witbank area rated ± 5 Mt/a ROM
- Delmas Colliery and plant is being looked at for re-opening by a black empowerment group.

CoalTech 2020

CoalTech 2020 is a collaborative research programme launched by the South African coal industry in 1998. The aim of the programme is to carry out research that will assist in the optimal use of South Africa's coal reserves. CoalTech 2020 funds a number of research projects in the areas of coal geology, underground and surface mining, coal preparation, the impact of coal mining on the environment and on water resources, as well as the human and social issues related to coal mining and the coal industry.

Dense medium fines beneficiation pilot plant

In past years, much of South Africa's export coal was produced from the No. 2 Seam where the fines fraction (0.5–0.1 mm) is relatively easy to beneficiate in spirals to an export grade product (+27.5MJ/kg). As the No. 2 Seam reserves are depleted a larger proportion of coal will be mined from the poorer quality No. 4 Seam. The fine coal fraction from the No. 4 Seam is difficult to beneficiate and in many instances spirals are not capable of yielding an export quality product coal.

Dense-medium beneficiation of fine coal is not a new concept and has been used in South Africa previously. The dense-medium fine coal plant at Greenside Colliery operated for almost 18 years and, despite proving a difficult plant to operate, did succeed in producing a fine coal product with a low ash content of 7%. No other beneficiation process available could achieve this. As there is a definite need to produce fine coal at export product quality from the No. 4 Seam, dense-medium beneficiation of fine coal was reconsidered.

Dense-medium beneficiation has the potential to beneficiate the fine coal from the No. 4 Seam to the required quality and further has the potential to be more efficient than spirals. The process also offers better control over product quality as shown in Figure 4.

The Greenside plant employed small (150 mm diameter) cyclones operated at relatively high feed pressures of about 150 kPa. Very fine magnetite (50% finer than 10 micron) was specified for the optimum operation of the plant. The plant proved difficult to operate but nonetheless delivered the required products. The need, however, was to develop a more 'practical' process that uses larger cyclones, lower pressures and commercially available super-fine magnetite, yet still gives a sharp separation. This is quite a challenge and formed the basis of a project.

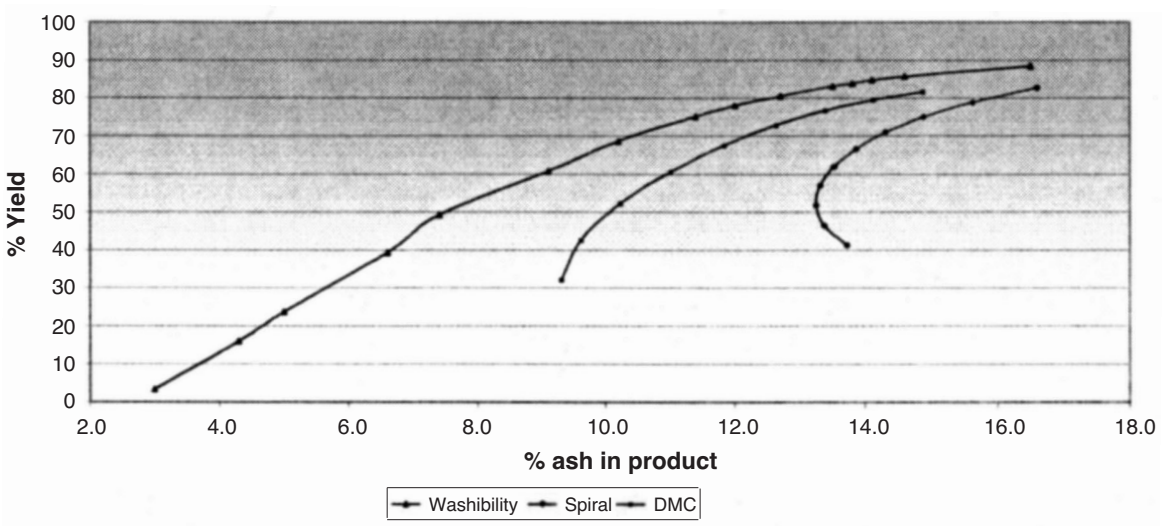

Figure 4—Ash/yield relationship. Spiral and DMC vs. washability No. 4 Seam

A study aimed at re-evaluating dense-medium cyclone processing of fine coal was motivated to the CoalTech 2020 Steering Committee and they agreed to sponsor a project. To prove the process technically viable, however, it was necessary to test it on a practical scale and a pilot plant was duly constructed and tested.

The design of the plant is unique in that dense-medium cyclones are used in a rougher-cleaner-scavenger arrangement. It was found, from the simulation studies conducted, that the Ecart Probable Moyen (Epm) could be lowered significantly by employing three stages of cyclones as shown in the flow sheet of the test plant (Figure 5), rather than a single cyclone as has been used in all previous dense-medium fine coal plants. It was anticipated that this would allow larger cyclones, lower feed pressures and slightly coarser magnetite to be used.

The three key features in the process design are:

- Triple stage dense-medium cyclones
  - Rougher : 420 mm dia.
  - Cleaner : 350 mm dia.
  - Scavenger : 250 mm dia.
- Counter-rotation multi-pole magnetic separators
- De-sliming of the feed coal at 100 micron by the Delkor Fast Screen.

The pilot plant was installed at Koornfontein Colliery and treats a portion of the existing spiral plant feed. The coal is de-slimed at 100 micron using the Delkor Fast Screen. Head feed to the plant is 25 tonnes per hour. The de-slimed feed amounts to approximately 20 tonnes per hour and is dewatered using a conventional dewatering screen. The dewatered feed is mixed with the medium and pumped to the primary (rougher) dense-medium cyclone. The overflow from the primary cyclone is mixed with circulating medium and pumped to the floats (cleaner) cyclone. The primary cyclone underflow is mixed with circulating medium and pumped to the sinks (scavenger) cyclone. The plant currently treats No. 2 Seam.

The overflow from the floats cyclone reports to a static screen. Part of the medium is recovered through the screen and this medium is pumped to a densifier cyclone for cleaning. A portion of the densifier cyclone overflow is sent to the product magnetic separator. The densifier underflow is returned to the circulating medium tank.

The product screen overflow is diluted with water and sent to the product magnetic separator. The magnetic separator underflow constitutes the final product. This product, in slurry form, is pumped back into the main plant to join the existing spiral product prior to dewatering. The recovered magnetite is gravitated to the circulating medium tank. The underflow product from the floats cyclone is re-circulated back to the primary cyclone feed.

The sinks (scavenger) cyclone processes the primary cyclone underflow stream. The sinks cyclone underflow is diluted with water and sent to the sinks magnetic separator.

The magnetic separator underflow constitutes the final discard. The discard is pumped to the main plant where it joins the existing spiral plant discards. The recovered magnetite is sent to the circulating medium tank. The sinks cyclone overflow is recirculated back to the primary cyclone feed.

The plant was commissioned during November 2001 and is operating effectively, producing the required product quality. However, one must bear in mind that the testing programme has just begun. Two efficiency tests have been conducted to date. The results are given in Table IV.

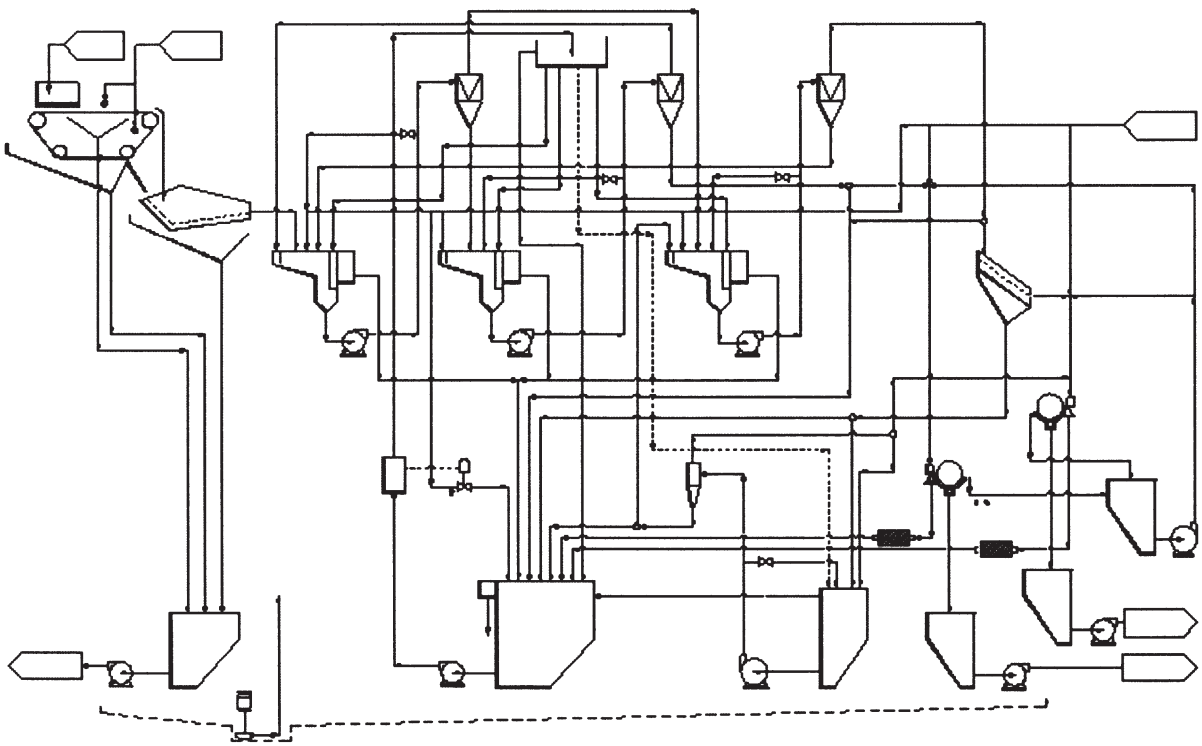

Figure 5—Flow sheet of test plant

Table IV

Efficiency test results: CoalTech 2020 test plant

	Test 1 30 November 2001	Test 2 30 January 2002
Feed % ash	21.2	21.5
Product % ash	17.8	15.6
Discard % ash	55.9	58.2
Product yield	91.2	86.1
D50	2.14	1.83
EPM	0.051	0.066
Organic efficiency	98.9	98.5
Sink in float	1.06	1.64
Float in sink	3.70	2.37
Total misplaced	4.76	4.01

The performance of the magnetic separators has been found to be very good. The magnetite consumption measured to date is about 1.5 kg per tonne treated.

The plant is being moved from Koornfontein to South Witbank Coal mine for further testing on the No. 4 Seam.

Dense-medium cyclone

The two factors that influence the capacity of cyclones treating low yield ores the most, are the medium-to-ore ratio and the rejection capacity of the cyclone spigot (or apex). The minimum feed medium-to-ore ratio recommended is 2.5 to 1. This is, however, recommended only for ores with low amounts of near gravity material. For the typical South African ore, a medium-to-ore ratio of 3.5 to 1 is recommended. At this medium-to-ore ratio and a maximum spigot size, the reject capacity of a standard DSM design cyclone will be in the region of 50% of the feed to the cyclone. In cases where the yields are below 50%, the medium-to-ore ratio must be increased in order for the cyclone to be able to handle the rejects. This normally results in larger or multiple cyclones being required to treat the ore.

The need for a separation unit capable of handling a larger percentage of rejects therefore arose. The rejector cyclone was developed by Multotec to meet these design criteria.

The design is an evolute off-take cyclone with reject capacities of up to 7 times higher than the maximum capacity of a conventional cyclone. This very high underflow capacity led to misplacement of clean coal to the rejects of the rejector. Some sort of back pressure was needed to reduce the misplaced clean coal to the rejects. The reduction of the spigot size could cause blockages and an external device needed to be developed. After testing many devices, the addition of a vortex extractor, similar to that used by the Vorsyl Separator, fitted to the underflow of the rejector solved this problem.

The obvious benefits of the rejector are that fewer units are needed to treat the same amount of ore. The added benefits are lower medium-to-ore ratios, resulting in lower volumes of media in the circuit, smaller media circulation pumps and less energy requirements due to smaller pumps.

A prototype of a 660 mm diameter rejector was built and tested on a coal treatment plant. Between feed rates of 100 to 180 t/h and spigot sizes from 90 mm to180 mm diameter the Epm varied between 0.015 and 0.030 and organic efficiency dropped from 95% to 84%. At 220 t/h feed rate and a 120 mm diameter spigot the Epm was 0.049 and the organic efficiency 77%.

Some of the back pressure devices tested are given in Figure 6 and the rejector fitted with the vortex extractor is given in Figure 7.

The concept of the rejector cyclone has been patented. The evolute offtake and the vortex extractor will be manufactured of mild steel ceramic lined sections, while the option of cast iron or mild steel ceramic lined parts will be available for the rest of the cyclone.

The major field of application is on Run of Mine ores with yields below 50%. A further area of application will be in the treatment of primary process discards. The rejector is currently being tested on a discard re-treatment plant. The combined discards from a drum plant and a cyclone plant are crushed to –19 mm and fed to the rejector cyclones. The rejector cyclone is still in the development stage and will be re-introduced into the market on the successful completion of further testwork.

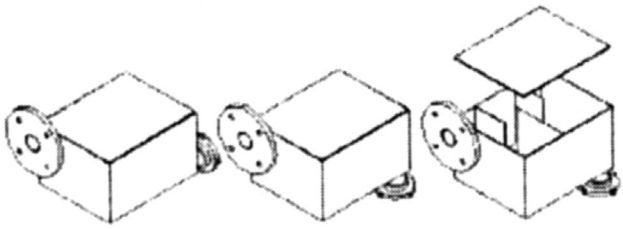

Figure 6—Back pressure devices

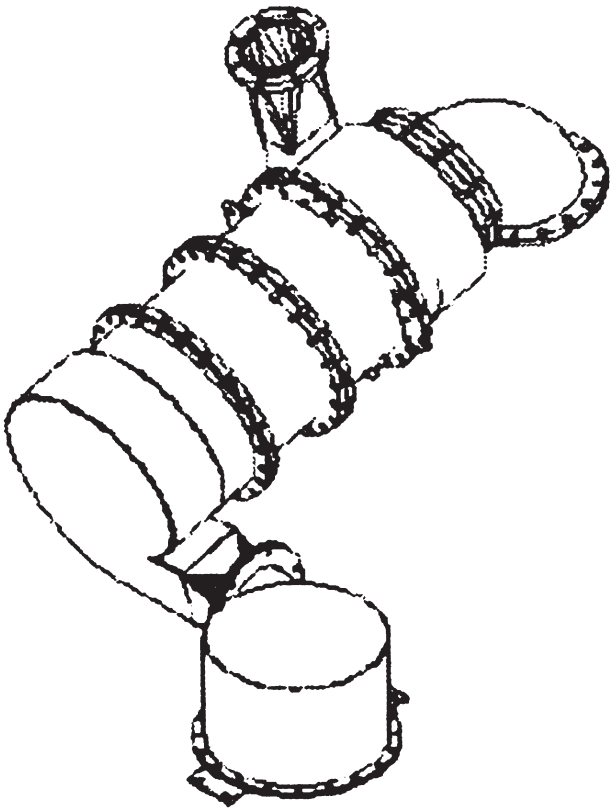

Figure 7—Rejector fitted with a vortex extractor

Fast screen

The tendency for overgrinding in milling circuits, as well as the inherent benefit in product upgrade with the removal of fines, led to the development of the fast screen based on the original Delkor Linear Screen.

The unit is largely based on the principle that feed is distributed over the effective screening area, and the linearly rotating cloth carries the oversize material to the discharge roller. Fine material passes through the cloth and is discharged separately. The patented FAST (Fines Alleviation Separation Technology) Screen has a number of modifications to assist in solving problems associated with fine screening.

Previous attempts at utilizing fine weave cloths with high open areas have failed, as cloth tracking invariably led to creasing of the cloth, and subsequent mechanical failure. This has been overcome by employing the use of the patented Trackmatic cloth as a carrier for the fine weave cloth. The Trackmatic cloths are widely used in the food industry, and their rugged design provides an ideal solution. The design of the Trackmatic requires a grooved head and tail pulley system, thus facilitating self tracking and solving another of the previous bottlenecks.

The fine screening cloth is attached to the carrier cloth with a patented eyelet and flexible cord system to allow for differential movement between the cloths.

Due to the inevitable variation in feed to processing plants, the screen is fitted with a variable speed drive, and this also assists in optimization of bed depth and fines recovery.

Due to the static nature of the linear screen, fines can and do get trapped on the oversize remaining on the cloth. Oversize spray bars are fitted above and below the cloth to assist in tumbling of the material, resulting in maximum fines removal efficiency.

The FAST screen has application in the mining and heavy industry arenas, with screening of cyclone overflow, underflow, and even in some cases, cyclone replacement.

The prototype was installed on a major South Africa Colliery, with the objective of removing as much of the ash bearing -45 micron material as possible. A 12m^2 FAST screen was installed and the preliminary results achieved are given in Tables V (a) to (d).

Other results

Undersize in oversize : 6,3%

Oversize in undersize : 2,6%

The fast screen was used in the dense-medium fines beneficiation plant and promises to be a major benefit in the classification of fine ore slurries.

Kroosher screening

The Kroosher is an add-on device to vibrating screens which requires no electric, pneumatic or hydraulic supply and no external power/drive. It is a fully mechanical hermetically sealed device made of stainless steel and can perform in all kinds of environments, no matter how difficult or chemically aggressive. Kroosh Technologies claim that once the Kroosher is applied to a screen, it can transform it from a low energy, single-frequency, past resonance (over tuned) linear system to a high energy, multi-frequency, strongly non-linear system, which stays in resonance mode at all times. As a result, the efficient use of power of a screen is increased from 1% or under to 10, 20 and even 30% (depending on the screener). The Kroosher uses a principle that excites the screen cloth rather than the screen body. It does so by altering the single-frequency vibrations into chaotic multi-frequency vibrations. Due to the multi-frequency every particle finds its own resonance frequency and the particles are excited a lot faster. The number of offerings to an aperture is eventually increased which increases the throughput and efficiency of the screen.

Productivity is increased by times or even orders and not merely by percentage. It is now possible to screen through much finer meshes as well as to screen previously un-screenable materials. The Kroosher guarantees:

- blinding-free processing
- multiplied productivity

Table V (a)

Test conditions	m^3/hr	t/hr	Solids%
Feed	154	33	20.1
Oversize	56.4	17,2	27.7
Undersize	166.8	15,8	7.0
Spray water	96.4	-	13.5
S50	169µ	-	-

Table V (b)

Feed				
Size (µm)	Frac. mass %	Cum. mass %	Ash %	Cum. ash %
+106	60.7	60.7	17.7	12.0
-106+75	4.9	65.6	18.6	12.5
-75+45	6.7	72.4	31.7	14.3
-45	27.6	100.0	36.8	20.5
Total	100.0		20.5	

Table V (c)

Oversize				
Size (µm)	Frac. mass %	Cum. mass %	Ash %	Cum. ash %
+106	94.8	94.8	19.4	12.1
-106+75	2.4	97.2	26.2	12.4
-75+45	1.6	98.8	35.9	12.8
-45	1.2	100.0	38.5	13.1
Total	100.0		13.1	

Table V (d)

Undersize				
Size (µm)	Frac. mass %	Cum mass %	Ash %	Cum ash %
+106	16.1	16.1	17.7	16.0
-106+75	11.1	27.2	23.5	19.1
-75+45	17.8	45.0	28.9	23.0
-45	55.0	100.0	34.8	29.5
Total	100.0		29.5	

- higher quality
- increased efficiency
- prolonged life span of the screen.

The Kroosher is used for both dry and wet applications, anywhere there is a vibratory screening process and can be applied to all types of screeners, whether vibratory, gyratory, rectangular or circular, whether large or small, including the tumbler screening machines. It works with all types and sizes of meshes and with all materials. Its capacity ranges from the screening of pharmaceutical products for 15 microns and even below on a small circular screener to an ore screening in an open-pit mine on a large rectangular machine for 40 mm and over.

A Kroosh screen test unit, 1 m wide by 2 m long,rated at 25t/h was commissioned at the Optimum Colliery spiral plant on 15 July 2002 in a sizing application.

Two sets of samples were taken on the screen at different frequency settings, i.e.:

- 50% Flyweight setting : Sample 1
- 70% Flyweight setting : Sample 2.

Samples of the feed overflow and underflow were taken and analysed for sizing, ash, calorific value, total moisture and solids concentration. The results are given in Table VI.

Figure 8 gives a comparison of partition curves for the Kroosh Screen vs. hydrocyclone.

A second installed unit is currently being tested in a dewatering application and 18% moistures are reported on d_{50} 45 micron material. Unit capacities are still to be determined.

Due to capacity restraints and concerns over the life of the screen, the unit has not yet found wide acceptance in the coal industry. There is still a lot of testing to be done, but initial results are creating a lot of interest in the technology.

Ultrasonic treatment of slurries

Sound waves with a frequency above 20 kHz are inaudible to the human ear. This regime of wave is referred to as ultrasonic and is of interest because of its potential to assist in mineral beneficiation.

The role of ultrasonic treatment in minerals processing is an indirect one. The key function of this treatment is the provision of microscopic scrubbing of the particle surfaces—rendering the particles more amenable to downstream treatment processes such as flotation and leaching.

The scrubbing itself is brought about by highly localized release of energy accompanying bubble collapse on the surfaces of particulate matter—the bubbles themselves being a by-product of ultrasonic treatment of the slurry.

Thermodynamics dictate that bubbles formed ultrasonically tend to collect on the surfaces of particles. A consequence of this is that collapse of the bubble means a release of the bubble energy on or near the surface of a particle. Collapse of the bubble can result in:

- Jets of liquid moving through the bubble at great velocities, typically hundreds of metres per second
- The formation of shockwaves.

Both of the above mechanisms accompanying bubble collapse can be very disruptive to particle surfaces. This disruption results principally in the erosion of the particle surface. However, it is also possible to crack and remove complete layers of gangue that may be shielding or occluding minerals.

Coal is often upgraded by flotation. The process depends upon the coal particles being hydrophobic. If the coal

Table V

Sample 1	Sample 2
O/f Recovery : 81.12% U/f Recovery : 18.8% Feed solids Conc : 177 g/*l* U/F solids Conc : 44.3 g/*l* % Moisture o/f : 35.5%	O/f Recovery : 76.89% U/f Recovery : 23.11% Feed solids Conc : 198 g/*l* U/F solids Conc : 58.3 g/*l* % Moisture o/f : 33%

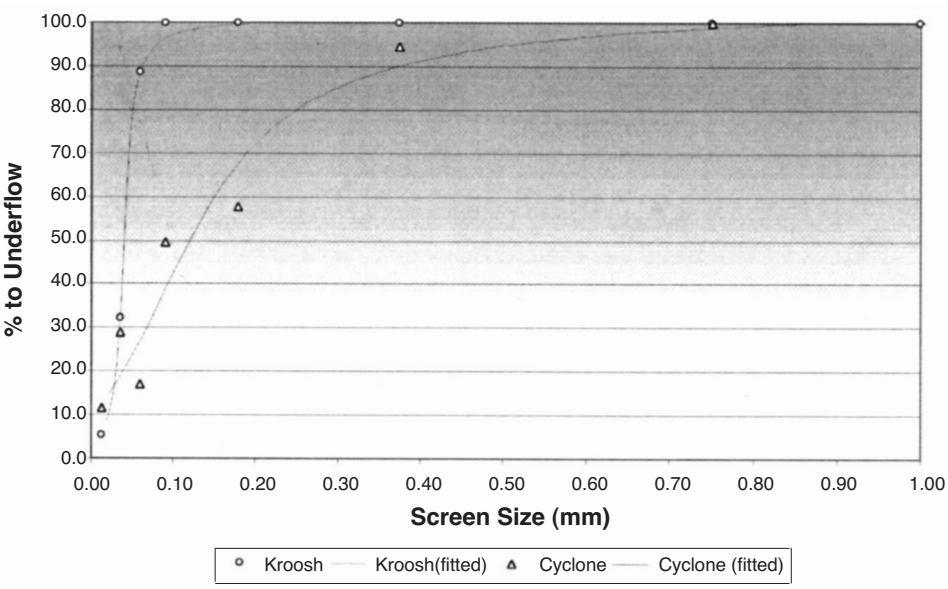

Figure 8—Partition curve—Kroosh screen vs. hydrocyclone

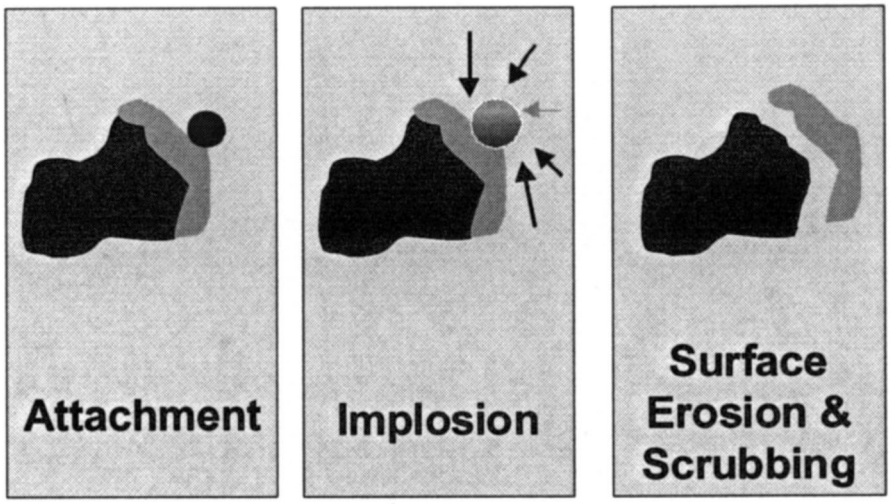

Figure 9—Illustration of particle scrubbing sequence

particles are coated (or partially coated) with clay, or an oxidized coal layer, the reagents do not see the particle as hydrophobic, but hydrophilic. Consequently, a particle, predominantly coal, but with a coating of foreign material, may not report to a product stream, but to tails. Removal of the occluding layer gives the flotation reagents access to the coal and improves yield.

A Dager ultrasound processor utilizing piezoelectric transducers has been imported and installed at Pretoria University's Department of Metallurgical Engineering for test-work on South African coals and minerals. This is a full-size well-proven and durable unit with the capability to operate in both batch and continuous modes. It is modular and easily transportable and operated off a 220 V power supply.

The first results on coal samples were very promising and show clearly improved recoveries. Figure 10 shows a synopsis of the initial testwork done at the University of Pretoria.

In addition to the work at the university, the test unit has been employed on a coal mine at a laboratory level but utilizing samples from the plant on a daily basis. Results have exceeded expectations, improving both grade and recovery.

Ultrasonic assisted treatment of minerals has moved from the domain of research to that of being an established technology within the USA. Test work indications from South Africa, although in their infancy, are indicating every possibility of the technology becoming established here.

Flotation

Contrary to the fine coal behaviour in the rest of the world, -0.5 mm South African coals are very difficult to float and need very high amounts of flotation reagents, which result in high reagent costs per tonne of product. It is for this reason that the flotation devices need to have high organic efficiencies in order for a project to be viable.

Extensive test work has been carried out in South Africa on the flotation of fines 0.5–0.1 mm and ultra-fines -0.1 mm. Conventional open trough cells, circular cells, Jameson cells, column cells and turbo columns, to name but a few, have all been tested. Generally speaking, in the Witbank area flotation is only carried out on the ultra-fines (-200/100 micron), with spirals currently being preferred for the fines fraction.

An excellent paper was given at the XIV International Coal Preparation Congress in March 2002 on flotation at Goedehoop Colliery. After test work had been completed on the -150micron fraction using the Wemco and Jameson test cells, Anglo Coal decided to develop a new cell that would combine stirred tank and quiescent column technology. The new cell is called the multi-cell. On the particular coal the multi-cell performed better than its counterparts and Anglo Coal as a consequence has patented the technology.

A schematic layout of the multi-cell is given in Figure 11 and performance indicators for the three cells tested in Table VII.

Notwithstanding the findings at Goedehoop, other producers carried out their own test work and we have seen the installation of a variety of cells in recent years. These include columns, turbo-columns, Jamesons, Smart cells and conventional mechanical cells.

Before deciding on any process route involving froth flotation, it is essential that adequate test work be carried out on the feed material. A general standard for fines test work in South Africa today includes all or part of the following:

- Screening at 2 mm, 0.5 mm and 0.1 mm
- Float and sink washability tests on the 2–0.5 mm and 0.5 x 0.1 mm fractions
- Spiral tests on the 2–0.5 mm and 0.5 x 0.1 mm fractions
- Flotation test work on all 3 fractions
- Scrubbing of the fines and flotation testing of all 3 fractions
- Reagent optimization.

Having selected the preferred sizing and process route, samples can be tested using the different types of cells.

Because of the specialist knowledge and techniques required in testing fine coal and the amount of test work involved, some producers are now using specialist companies to carry out the work on their behalf. Contractor operated fines treatment plants are also being considered by some producers.

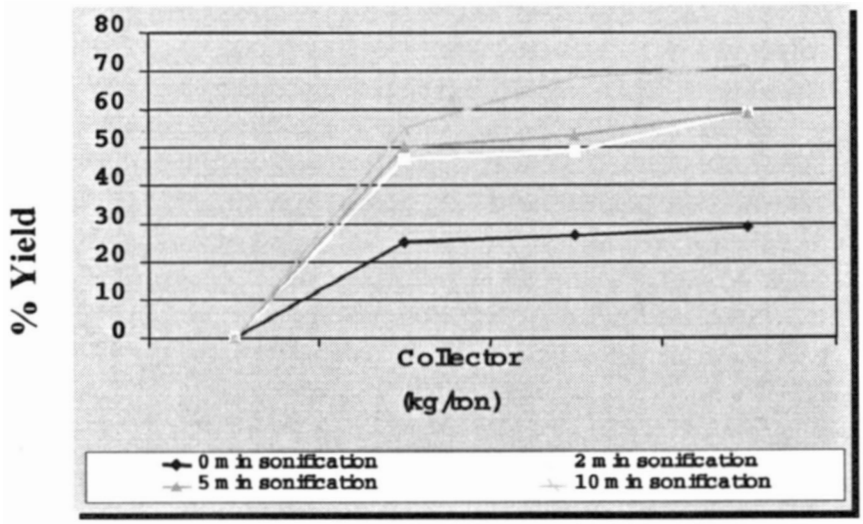

Figure 10—Float yield versus collector concentration

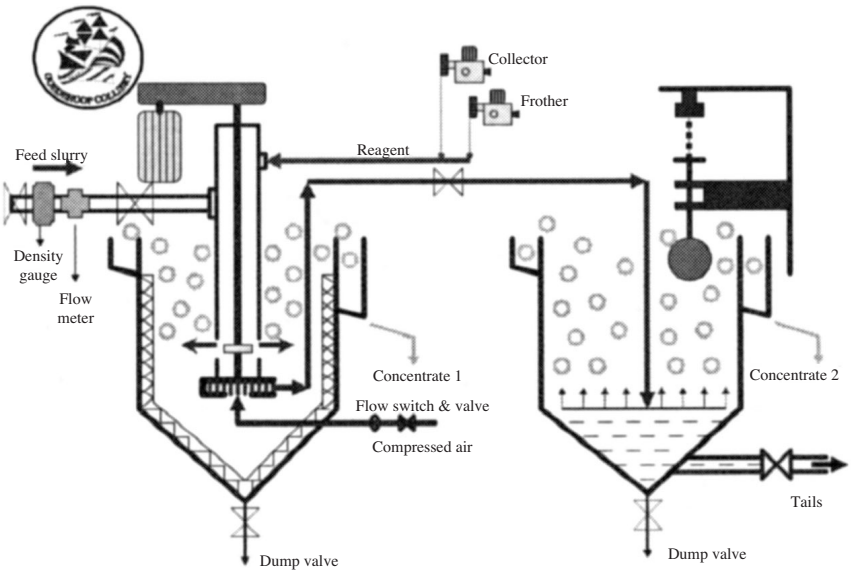

Figure 11—Multi-cell schematic

Fine coal dewatering

There two interesting developments in fine coal dewatering are the development of a hybrid solid-bowl centrifuge and the use of filter presses for froth flotation concentrate.

After flotation the froth is conventionally broken down mechanically and then pumped with a specially designed froth pump into a mixing box where it is mixed with spiral product. From the mixing box the slurry mixture is fed into the screenbowl centrifuge and dewatered. Test work indicated that 90% of the feed solids can be recovered at 16% surface moisture when feeding the screen-bowl at a 75% spiral / 25% flotation ratio. Recovery in the screen-bowl starts dropping dramatically as the flotation material increases above 50% in the feedstock with an increase in surface moisture going up to 22%. Most of the losses occur through the screen section of the machine.

The solid-bowl test unit improved recovery of the ultrafine material but at high surface moisture (with the exception of a 100% spiral feedstock). A comparison between the screen-bowl and solid-bowl is shown in Table VIII.

The increased recovery of solids and increase in surface moisture prompted the modification of a full-scale screen-bowl to a hybrid solid-bowl at Goedehoop Colliery. The hybrid solid-bowl has a much shorter screen section when compared to a conventional screen-bowl. This screen section allows for extra dewatering at the discharge end of the machine through the short screening section and it is expected that solids losses will be significantly less than with the conventional screen-bowl machines.

Test work is ongoing to determine the effect of the actual decrease in gross as received (kcal/kg) heat value of the final product versus the expected decrease.

Table VII

MACHINE TYPE PLANT ARRANGEMENTS		WEMCO 1 TEST CELL	JAMESON 1 TEST CELL	MULTICELL 1 PRODUCTION CELL
Date		01/97 – 12/97	01/98 – 12/98	06/99 – 12/2000
		Average	Average	Average
Feed solids	%	3.1	4.50	5.5
Product solids	%	9.4	11.0	14.2
Tailing solids	%	0.9	3.1	1.9
Feed ash	%	17.2	17.0	17.6
Product ash	%	9.8	8.0	8.5
Tailing ash	%	49.3	23	45.0
Product recovery	%	81.26	40.0	75.07
Combustible recovery to product	%	88.53	44.34	83.36
Reagent consumption	Kg/t	6.3	5.9	3.0
Capacity: pulp	m^3/hr	6.2	1.38	250.0
Capacity: dry solids	t/hr	0.19	0.06	13.0
Unit capacity: pulp	m^3/h/m^3	17.71	19.53	9.62
Unit capacity: dry solids	t/h/m^3	0.54	0.85	0.5
Power consumption				
• Pulp	KWh/m^3	0.87	-	0.24
• Dry coal	KWh/t	5.7	-	4.6

Table VIII

Float product in feed %	Surface H_2O %		Recovery %	
	Screen bowl	Solid bowl	Screen bowl	Solid bowl
0	14.47	7.92	91.92	99.95
25	16.55	22.47	90.17	98.64
50	21.31	24.66	82.90	99.75
75	21.96	29.26	32.31	96.65
100	33.01	38.42	7.64	97.61

One of the latest developments in fine coal dewatering is the use of filter presses for dewatering froth coal as opposed to tailings. Compared to the past, where the froth concentrate was first thickened prior to being pumped to the presses, the froth is now fed via a surge tank fitted with an agitator to break the froth, then pumped directly to the presses without the need for a thickener. To reduce press cycle times and therefore reduce the size of the filter plant, high volume quick-fill pumps are used in the press plant design. Final moisture contents of 20% are achieved.

Other developments in coal preparation

It is not possible to cover every aspect of development in a review paper, so selected areas based on the author's preference have been reviewed in more detail than others. The South African papers given at the XIV International Coal Preparation Congress in March 2002 give a more extensive view of the current developments in technology within the country.

Other developments include the installation of a ROM jig at Optimum Colliery to de-shale the plant feed prior to feeding the export washing plant. The jig is a Humboldt pulsating plate type, treating 300–50 mm Run of Mine coal. It is the first of its type in South Africa. Whilst it is difficult to sample coal with a 300 mm top size the jig is reported to be working well with no apparent coal losses visible in the discard.

Jig plants are being used on small contract operations to re-wash discards to between 19 and 23MJ/kg for power station feedstock.

CSIR-Miningtek is carrying out extensive laboratory testing on producing binderless briquettes from the Witbank coals. Materials being tested include -0.1 mm flotation fines.

Tri-flo separators are being tested alongside the Rejector cyclone on low yielding coals (discards)

Hydrosizers or teeter bed separators are being tested on fine coal as an alternative to spirals.

Paddock drying of fines is being tested as an alternative to mechanical dewatering.

Different types of crushers for crushing discards for re-treatment are undergoing tests. These include ring granulators crushing down to -20 mm and cone crushers crushing down to -12mm. Plant yield increases of 0.63% are estimated for the finer crushing on one particular colliery.

The following is an extract from the Larcodems paper presented at the XII Congress in Australia and refers to the use of Larcodems on the treatment of iron ore at Sishen.

'Design is currently underway for retrofitting a 1 200 mm Larcodems vessel into Iscor's Sishen iron ore mine. The vessel will be tested against a heavy media drum on one of the coarse (-90mm + 25mm) modules. Efficiency in terms of cutpoint and misplacement will be compared to the drum module at densities of 3.6 to 3.8 as density is increased to 4.1. The drum module currently processes 600t/h of iron ore and the Larcodems circuit is being designed to treat 800t/h (nominal) and 1000t/h (design).

Unique aspects of the circuit are:

- The correct medium circuit has been designed to treat densities up to 4.1 RD (88.1% solids w/w). This high density is attainable due to Sishen's use of a licensed manufacturing process for ferrosilicon.
- Temperature monitoring and alarm annunciation of the correct medium is being incorporated in line with known viscosity effects.
- Two-stage centrifugal pumping of the correct medium is proposed with on site test work currently underway to establish pump de-rating factors. A dramatic increase in medium viscosity has been established at the proposed maximum circulating density. The first stage will use a fixed speed expeller seal with the second stage utilizing an AC frequency inverter and gland seal. Pump motors are provisionally sized at 500 kw/stage and will be confirmed on completion of test work.'

The plant has been successfully commissioned and an excellent presentation on the testing and performance of the unit was given to the South African Coal Processing Society by the Manager, Kumba Ferrosilicon, Sishen. While the paper is on iron ore and not coal, it is a dense-medium process and is of technical interest. The presentation is titled 'Larcodems at Sishen' and can be viewed on the SACPS website www.sacoalprep.co.za.

South Africa now has 5 Larcodems operating on coal, 2 at Duvha, 1 at Tavistock, 1 at Tavistock re-wash plant and 1 at Witbank Consolidated.

General

Opportunities facing the coal industry at the moment include:

- An increase in coal burnt by Eskom. The trend is for a 3 to 4% increase in 2003, up from 96.46 Mt of coal burnt in 2002, and an anticipated growth rate of 1.8% per annum thereafter
- Mothballed power stations may be re-opened to meet the increase in demand (Camden, Komatipoort)
- There is a shortage of rail trucks, engines and crews to move the increased tonnage and consideration is being given to the installation of a major overland conveyor system to selected power stations.
- Re-mining of pillars is now a reality on at least four collieries (New Vaal, Douglas, Atcom and Navigation). De-volatalized coal makes it difficult to flocculate and oxidized coal makes it difficult to float. Contamination of wood and tramp in the ROM make it difficult to handle.

The World Summit on Sustainable Development was held in South Africa in August 2002. Two topics from South Africa are included for the delegates' information. The first is titled 'Declaration of Intent on Coal and Sustainable Development in Developing Countries' given in Figure 12 and the second 'Clean Energy Strategy for Households in SA' given in Figure 13.

The two papers give some indication as to the importance coal plays in the long-term economic development and health of the country and the importance attached to it by government.

Closing comments

Coals in South Africa are generally very difficult to wash, being high in near gravity material and generally having poor flotation characteristics. The markets it supplies are many and varied, both inland and export. Qualities produced range from 16 MJ/kg for Eskom power stations to 7% low ash coking coal and vary in size from large nuts 75–40 mm to duff 6–0 mm. It is not unusual for some mines to produce 5 different size ranges and 2 or 3 different qualities. Multi-seam mining of coals of different quality often makes the task for the coal preparation engineer even more difficult. For these reasons many of the coal preparation plant designs in South Africa are more complicated than the single product single market mines often seen elsewhere round the world. These are the challenges that make being a coal preparation engineer in South Africa so exciting.

On a clear day, if one stands on the hill at Komati power station in Mpumalanga and looks around 360 degrees, one will see the 'coal revolution' of Southern Africa. A total of eight power stations, all coal fired, can be seen producing over 18 000 MW or roughly 60% of the country's electrical needs. On the southern horizon one can discern the stacks at Secunda where Sasol has the largest oil-from-coal plant in the world consuming 50 Mt/a. At the foot of the hill passes the Richard's Bay rail line, carrying 70 Mt/a of coal for export. Not quite so visible, hidden in the folds of the landscape, lie the numerous collieries and coal preparation plants producing the coal needs to fuel the nation's economy.

Only a short 35 years ago in the same spot one would have seen mostly open veld. From being a late starter, South Africa has, in a short space of time, caught up with the rest of the coal preparation world. From a mere 50 Mt of sales in 1968 to 227 Mt in 2001, the industry has built a reputation for reliability and quality of which it can be justifiably proud.

Acknowledgements

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- Hennessy, M — Celtic Coal Developments
- Lok, G. — CSIR Division of Mining Technology
- Michael, D.C. — DCM Coal
- Schiefer, F. — Kroosh Africa
- Terblanche, N — PrepQuip
- Van den Berg, A.J. — Ingwe Coal

WSSD COAL CONFERENCE

"Coal and Sustainable Development in Developing Countries"

BACKGROUND IN WHICH THIS DECLARATION SHOULD BE READ:

This Declaration of Intent is not a representative document for Developing Countries producing and/or using coal. However, it could form the basis for such a document in future.

South Africa, as a major coal producing and using Developing Country, will be dependent on coal for a major part of its future energy needs to achieve the objectives of sustainable development. In realizing this fact, firm commitments regarding coal as a resource is needed by all South African stakeholders. This Declaration is intended as a position statement of South African stakeholders on commitments to realise the full potential of coal to achieve the objectives of sustainable development for the improvement of quality of life for all.

The following Key Result Areas (KRAs) have been identified based on:

1. Internationally accepted goals for the global coal industry and
2. The 9 principles of the UN's Global Compact on Human Rights, Labour Standards & the Environment

DECLARATION OF INTENT

The coal industry stakeholders will:

1. Implement the principles of sustainable development by strong leadership and multi-stakeholder partnerships;
2. Promote the understanding of the principles of sustainable development within the government, coal industry and local coal mining communities;
3. Improve the health & safety performance of coal mining and minimise its environmental impact on the biosphere (air, water, land) and local communities;
4. Reduce the environmental impact of coal use by efficiency improvements in coal technology;
5. Promote the transfer and implementation of new and advanced cleaner coal technologies and carbon capture / sequestration technologies from developed countries to developing countries and vice versa, for emissions reduction;
6. Improve the collection, collation and distribution of coal information regarding environmental, health & safety impacts for enhanced transparency and exposure to ensure good performance;
7. Support community development initiatives by addressing local sustainability issues, such as to establish management programmes for HIV/AIDS in the workplace, provide enhanced economic and social opportunities for poverty alleviation and establish programmes to reduce the emissions of coal in households.

Figure 12

World Summit on Sustainable Development (WSSD)

CLEAN UP OF SOWETO

"Clean Energy Strategy for Households in SA"

Focus

Emphasis is on the poor, low-income households mainly dependent on coal as a household fuel. The health and environmental impacts is most prominent in these households because of the way coal is being used, in open fires, mbawulas and old stoves.

Strategy Options

Strategy options were identified to reduce coal-based household pollution, classified from least-cost to more expensive options.

Refine equipment	Reduce energy need	Replace coal	
"Basa Magogo"	Insulation	Electricity	
Stove maint. (chimneys)	Housing design	LSFs	
New Stove			Renewables

End-user criteria to determine whether an option is ready for implementation are:

- Efficiency in decreasing coal-based air pollution;
- Availability to end-users of coal;
- Affordability to both consumers & authorities;
- Sustainability in economical, social and ecological terms; Desirability for end-users; and
- Beneficiality, not replacing one problem with another.

Strategy is based on principle that solutions that comply to a sufficient level with the above criteria can be implemented immediately (fast tracked). Others need more investigation, refinement and/or financial support.

Apart from continued electrification of households, the only other solution that currently satisfies the criteria is the "Basa Magogo" (BM) ignition method.

Implementation (fast tracking) of "Basa Magogo"

1. Put together a team to demonstrate correct procedure for BM.
1. Demonstrate BM to authorities: National, Provincial & Local.
3. Target key communities: Soweto, Alexandra, Tembisa, etc.
4. Demonstrate & solicit support from community leaders.
5. Run pilot demonstration in approx 1000 households.
6. Train team(s) in communities to demonstrate BM.
7. Demonstrate BM on street level.
8. Consolidate implementation through formal public support.

Other potential solutions

Housing insulation: This option poses significant benefits as it reduces the need for energy in the household. No safe and affordable insulation material that complies with other criteria is yet available.

1. Interact with potential producers to convey end-user criteria to them;
2. Concentrate on the material characteristics & cost/home;
3. Evaluate availability;
4. WSSD donor funding to be investigated in Work Group session.

Low-smoke Fuels: As LSFs are more expensive than household coal, some form of financial assistance is indicated to make LSFs affordable to end-users. The minimum requirements for an acceptable LSF will be to perform better than household coal in terms of heat production and emissions. The National Standard on Low-smoke Solid Household Fuel that is currently being developed will determine the detailed requirements.

1. Finalise the National Standard in cooperation with SABS;
2. Interact with potential LSFs manuacturers;
3. Discuss issue of submission of Business Plans based on Tender;
4. Provide information on what fuels are available at what cost;
5. Potential fuel must comply with National Standard;
6. Indicate type and level of assistance needed; and
7. WSSD donor funding to be investigated in Work Group session.

Stove maintenance: Although fire-technology is more difficult to be understood by the end-users, there may be some instances where it could be successful. Where stoves are reasonably maintained, extension of chimney lengths could have significant improvement in coal combustion.

1. Team to demonstrate concept in pilot scale to be put together;
2. Evaluate pilot scale findings;
3. Determine practicality and advantages to implement on a wider basis.

Overall Target Objective

The overall target objective of the above proposed plan/strategy is to fast track those solutions that are implementable for the soonest reduction in the level of coal-based air pollution. Simultaneously, the more expensive options need to be developed and refined and where financial assistance is needed, to investigate the potential of WSSD donor funding for implementation, to further reduce household air pollution to internationally acceptable levels.

Figure 13

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