### %CHAPTER SEVEN - BENEFICIATION TECHNIQUES AND PROCESSES FOR OPTIMUM ENERGY RECOVERY AND POLLUTANT REDUCTION

In Section 7 the recovery of different pollutants, combustible material and energy recovery are evaluated on liberation or yield-recovery curves. The comparative energy and pollution recovery optimum can be deduced from the liberation curves. The data used in the yield–mineral rejection graphs were derived by plotting XRD data in Tables IV and V in APPENDIX E against yield. These curves are compared to the liberation data obtained through the QEMSEM analysis described in Section 4.7.

## 7.1 Process characterisation for the beneficiation of coal to reduce sulphuric related species and the associated trace elements

### Witbank Coalfield No. 4 Seam

The predicted reduction of sulphur by sizing is given by Figures 123 and 124 respectively.



**Figure 123:** Sulphur Recovery curve for Witbank Coalfield No. 4 Seam in various liberation size fractions.

In the Witbank Coalfield No. 4 Seam it can be seen that the sulphur components cannot be reduced by sizing at levels above a 70 % yield.

The best liberation achieved is in the -0.5 mm fraction. To liberate all the ROM material to this size would not be practical in industry at present. However a circuit is proposed to this effect in Chapter 8.1.6 where the products are produced as briquettes.





### Waterberg Upper Ecca

In the Waterberg Upper Ecca, different liberation characteristics of the sulphur are observed in Figures 125 and 126 respectively. The sulphur recovery curve illustrates that fairly uniform reduction in sulphur can be obtained for all the size fractions.



**Figure 125:** Sulphur Recovery curve for Waterberg Upper Ecca in various liberation size fractions.

In Chapter 5.1, Figure 93 gives an indication of the sulphur distribution in various low grade thermal export products, and that with an increase in product CV a corresponding increase in total sulphur can be observed for the Waterberg Upper Ecca, in contrast to the Witbank Coalfield No. 4 Seam.

The complex distribution of the sulphur at the various liberation size fractions still however remains, but due to the association of the pyrite not being strong with vitrinite a uniform reduction in sulphur content can be achieved through dense medium beneficiation.



Figure 126: Mayer curve distribution of sulphur for the Waterberg Upper Ecca

# 7.2 Process characterisation for beneficiation and optimal energy recovery

The concept of Optimal Energy Recovery Potential can be described as the optimal utilisation of energy harnessed from the earth, as mined coal energy. The concept of optimal energy recovery was developed during the research to describe the optimal energy that could be achieved through the processing of ROM coal. The optimum utilisation potential could be described as the use of raw ROM, which would yield a 100 per cent Energy Recovery in essence. With coal utilisation and environmental constraints this is not always viable. There is however a sub-optimum which would allow for optimal energy recovery. The pollution optimum for a given thermal export product and/or domestic product could be maintained when achieving the optimal energy recovery.

The Energy Recovery (ER) Index equation (between 0 and 100 %) can be given by:

### Equation 12: The Energy Recovery Formula

..... (12)

Where the

- (1) Energy Contained in the Product, refers to the thermal coal product after beneficiation in GJ/ton.
- (2) Process Energy Required refers to the mining beneficiation process energy
- (3) Energy Contained in ROM, refers to raw ROM heating value, prior to beneficiation

#### Witbank Coalfield No. 4 Seam

In the Witbank Coalfield No. 4 Seam from Figure 127 it can be seen that at low yields which is achieved at low cut point densities the energy recoveries are low. Towards the lower quality products and associated higher yields a non-uniform distribution is observed.



### **Figure 127:** Energy Recovery potential at various liberation size fractions - Witbank Coalfield No. 4 Seam

The Energy Recovery data illustrated in Figures 127 and 129 was generated through doing an energy balance and using Equation 12. The energy values calculated are

based on the CV values per density and/or size fraction on a mass (tons) basis. The Energy Recovery is to some extent correlated to the combustible recovery through the ash and CV relationship. The combustible recovery due to being calculated using the combustible balance as a deduction of the ash balance shows a more uniform relationship and can be upgraded readily at all density ranges. All size fractions display the same uniformity.



**Figure 128:** Combustible Recovery potential in various liberation size fractions Witbank Coalfield No. 4 Seam

### Waterberg Upper Ecca

In the Waterberg Upper Ecca a similar trend for both energy recovery and combustible recovery is observed. This indicates that liberation of the size fractions cannot readily increase the combustible recovery. To some extent an increase the energy recovery can be obtained. In Figure 129 to 130 the energy recovery and combustible recovery curves are displayed from data given in APPENDIX B1, B2 and B3. The energy recovery was calculated by the energy balance and using the Energy Recovery formula given as Equation 12.



**Figure 129:** Energy recovery potential for different liberation size fractions in the Waterberg Upper Ecca



