SULPHUR REMOVAL FROM COAL OR FROM PRODUCTS: IS PREVENTION BETTER THAN CURE ? – A TECHNO-ECONOMIC REVIEW

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DECLARATION

I declare that this thesis is my own, unaided work. It is being submitted for the Degree of Doctor of Philosophy in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

This 2nd day of March 2009

ABSTRACT

The gasification of coal to produce a synthesis gas for the production of synthetic fuels and chemicals in the Sasol Synfuel complex in Secunda produces an off-gas stream that contains sulphur compounds. The release of these compounds into the atmosphere is regulated, and significant efforts are required to meet the regulations. With increasing gas production rates and the likelihood that coal quality will deteriorate over time, options need to be evaluated to reduce the sulphur emissions.

This thesis investigates the origin of sulphur in the coal, the distribution of the species and the potential for removal of sulphur from the coal before the sulphur can reach the gasifiers. The coal beneficiation option is compared to two chemical processes, which capture the sulphur compounds after they are produced in the gasifiers. Several sub-systems are evaluated from a technical perspective to enable the design of suitable concepts as well as the economic evaluations of these concepts. Most of these sub-systems had not been properly evaluated before, including the evaluation of the gasification coal for beneficiation potential, for which a series of coal washability evaluations needed to be performed. The comparison is done on a techno-economic basis, to be able to answer the question: is Prevention better than Cure?

The conclusion is: it depends. On pure economic grounds and using traditional accounting methods, neither the coal beneficiation option nor the off-gas clean-up option is viable. Capital expenditure, operating costs and impact on the volume of saleable product lead to negative net present values for the all options considered. However, the establishment of a coal beneficiation system enables the complex as a whole to accept a wider range of coal for the processes, potentially unlocking a larger volume of coal from the coal reserves.

When the need to abate sulphur emissions is combined with long-term coal reserve utilization aspects, the coal beneficiation options are most definitely worth considering, as the potential additional income and extended complex life is valued at billions of Rand.

Discussions in Sasol about this research has contributed to a change in the reserve utilisation philosophy, and to the initiation of a large scale project to evaluate the implementation of coal beneficiation in the Sasol Secunda process value chain.
This is an acknowledgement of the value of this research.

ACKNOWLEDGEMENTS

This thesis is the final product of many years of work to develop and gather the information on which this thesis is based and to apply this to coal beneficiation in the Sasol Secunda complex. Coal characterisation and beneficiation potential determinations, evaluation of the effect of coal quality including sulphur on the gasification process, screening plant performance investigations, all had to be performed from scratch. Most difficult of all: the need for the investigations had to be motivated at various management levels before the actual work could proceed.

In the end, the co-operation of my colleagues in the Geology Department of Sasol Mining, the Gas Production department of Sasol Synfuels and the engineers and scientists of Sasol Technology made it possible that this research could be performed. Thank you.
The assistance of Jan Eklund with the beneficiation plant designs and cost estimates is greatly appreciated.

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A final “thank you” to my family for tolerating the late nights and weekends spent working on this thesis. Balance will soon be restored.

Ed. Koper

To my daughters Inge and Abby:

Luctor et Emergo

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