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

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A thesis submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Doctor in Philosophy.

Secunda, March 2009

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.

As special word of thanks to prof. Rosemary Falcon who took over the guidance for this research after prof. David Horsfall passed away and prof. JP Franzides moved to Australia. Her continued stimulation and requests for papers to be presented at conferences ensured not only that this thesis progressed to completion, but also that the topic was given a wider audience that led to a broader appreciation with many more people.

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

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To my daughters Inge and Abby:

Luctor et Emergo

CONTENTS Page

DECLARATION 2
ABSTRACT 3
ACKNOWLEDGEMENTS 4
CONTENTS 6
LIST OF FIGURES 9
LIST OF TABLES 12

1 INTRODUCTION 14
1.1 Background: Sasol's Coal Conversion Process 16
1.2 The Coal Resource 18
1.3 Process Consequences Of Coal Quality 24
1.4 Benefits Of Coal Beneficiation 25

2 OPPORTUNITY STATEMENT 27

3 BACKGROUND 30
3.1 The Origin Of Sulphur In Coal 30
3.1.1 Pyrite 30
3.1.2 Organic sulphur 34
3.1.3 Sulphur as sulphates 34
3.2 The Origin Of Sulphur In The Gas Stream 36

4 PREVENTION ALTERNATIVES 41
4.1 Sulphur Removal Before The Coal Utilization Process 42
4.1.1 Coal selection and the mining process 42
4.1.2 Biological treatment 44
4.1.3 Chemical treatment 46
4.1.4 Physical treatment: coal beneficiation 51
4.2 Sulphur Removal During The Coal Utilization Process 53

5 TREATMENT ALTERNATIVES 55
5.1 Sulphur Removal From The Product Gas 56
5.1.1 Sorbents 56
5.1.2 Absorption in methanol (Physical) 59
5.1.3 Chemical absorption 59
5.2 Sulphur Recovery And Conversion Into Saleable Product 61
5.2.1 Claus-type processes 61

5.2.2 Wet sulphur recovery processes 63
5.2.3 Direct conversion to sulphuric acid 64

6 COAL BENEFICIATION 66
6.1 Coal Beneficiation Technology Options 66
6.2 Dense Medium Separation Using Baths 68
6.2.1 Wemco drum separator 68
6.2.2 TESKA separator 69
6.2.3 Drewboy separator 70
6.2.4 Norwalt separator 71
6.3 Dense Medium Separation Using Centrifugal Force 72
6.3.1 D.S.M. cyclone 74
6.3.2 Dynawhirlpool separator 75
6.3.3 Vorsyl separator 76
6.3.4 LARCODEMS separator 77
6.4 Coal Beneficiation Using Jigs 79
6.4.1 Types of jigs 83
6.5 Technology To Use 87

7 EXPERIMENTAL WORK 88
7.1 Initial Coal Evaluations 88
7.2 Further Coal Evaluations 92
7.3 Coal Quality Basis For Research Project 97
7.4 Relation Between Sulphur In Coal And Sulphur In Raw Gas 103
7.4.1 Test facilities 103
7.4.2 Actual tests 104
7.5 **Coal Screening Plant Information 108**
7.6 Coal Beneficiation Equipment Performance Information 113
7.7 Chapter Conclusion 114

8 BENEFICIATION PLANT DESIGNS 116
8.1 Water-only Process Scenario (Jigs) 117
8.2 Dense Medium Based Beneficiation Scenario 118
8.3 Mass Balances – Coal 119
8.4 Mass Balances – Sulphur 122

9 FINANCIAL EVALUATIONS 124
9.1 Cost Estimates 125
9.3 Additional Costs And Benefits 127

9.4 Net Present Value of The Options 128
9.5 Financial Conclusions 129
9.6 The Bigger Picture 130

10 SUMMARY OF FINDINGS 136

11 CONCLUSIONS AND RECOMMENDATIONS 141

12 POST SCRIPT 145

APPENDIX A SEPARATOR PERFORMANCE INFORMATION 146
APPENDIX B PROCESS FLOW DIAGRAMS 153
APPENDIX C MASS BALANCES – COAL 155
APPENDIX D MASS BALANCES – SULPHUR 165
APPENDIX E ECONOMIC EVALUATIONS 172
APPENDIX F STANDARDS FOR COAL ANALYSIS 192

REFERENCES 193

SELECTED BIBLIOGRAPHY 202

LIST OF FIGURES

Figure		Page
1.1	Overview of the Sasol coal conversion processes in Secunda	17
1.2	Co-deposition of organic and inorganic material	19
1.3	Progression of coal deposit over time	20
1.4	Effect of drainage channels on Secunda coal deposit	20
1.5	Ash content distribution of the Secunda coal deposit	21
1.6	Sulphur content distribution of the Secunda coal deposit	22
3.1	Formation of pyrite through anaerobic bacterial conversion of sulphates	31
3.2	Finely dispersed pyrite in Secunda coal	32
3.3	Pyrite vein in Secunda coal	33
3.4	Discrete pyrite nodule in Secunda coal (torbanite)	33
3.5	Sasol-Lurgi Fixed Bed Dry Bottom Gasifier	36
3.6	Sasol Synfuels Secunda gas production block flow diagram	38
3.7	Process diagram of the Lurgi/Linde Rectisol process	39
4.1	TRW Gravimelt process for sulphur removal from coal	47
4.2	Solvent Refined Coal process	48
5.1	Tampa Electric Polk Power Station IGCC with hot gas clean-up	57
5.2	Typical amine system for hydrogen sulphide removal	60
5.3	Standard two-stage Claus sulphur recovery process	61
5.4	Oxygen-enriched Claus, COPE process	62
5.5	Standard Sulfolin process	63
5.6	Haldor Topsøe wet sulphuric acid process	64
6.1	FXG dry coal separator	67
6.2	Wemco dense medium separator	68
6.3	TESKA dense medium separator	69
6.4	Drewboy dense medium separator	70
6.5	Norwalt separator	71
6.6	Principle of centrifugal separation	72
6.7	D.S.M. cyclone	74
6.8	Dynawhirlpool separator	75
6.9	Vorsyl separator	77
6.10	LARCODEMS separator	78

6.11	Early jigging process	79
6.12	Stages of separation in jig operation	80
6.13	Near density material affecting sharpness of separation	81
6.14	Side air box (Baum) vs. under bed air box (Batac)	83
6.15	Baum jig	84
6.16	Batac jig, side view	84
6.17	KHD ROMjig	86
7.1	Sulphur distribution per size fraction, 1995 samples	96
7.2	Washability curves, plus 12.5 mm fraction	97
7.3	Washability curves, sinks (discards), plus 12.5 mm fraction	99
7.4	Washability curves, minus 12.5 mm fraction	99
7.5	Forms of sulphur, distribution in plus 12.5 mm fraction	100
7.6	Correlation, ash in coal and abrasiveness index	100
7.7	Frequency distribution, mass % sulphur in coal to gasifiers	100
7.8	Correlation between sulphur in coal and H_2S in raw gas	106
7.9	Summarized correlations between sinks, ash, sulphur and H_2S	107
7.10	Run of Mine particle size distribution, averaged, for design basis	109
7.11	Partition curves for coarse coal screening module	110
7.12	Partition curves for coal screening plant	112
9.1	Ash content distribution of the Secunda coal deposit	130
9.2	In-situ coal reserves versus ash content	132
A1	KHD jig partition curve, 80*10 mm sized feed	149
A2	Bath partition curve, e.g. Drewboy	150
A3	LARCODEMS partition curve, as per CRU Duhva	151
A4	Large diameter cyclones partition curve, 1000 mm ID	152
B1	Generic PFD, Beneficiation of Gasification coal with Jigs	153
B2	Generic PFD, Dense Medium Beneficiation of Gasification coal	154
C1	Block flow diagram and stream summary: standard SSF	155
C2	Block flow diagram and stream summary: Jigs	157
C3	Block flow diagram and stream summary: Dense medium cyclones	159
C4	Block flow diagram and stream summary: Baths	161
C5	Block flow diagram and stream summary: LARCODEMS	163
D1	Sulphur mass balance: Base case, Sulfolin bypass open	165

D2	Sulphur mass balance: Base case + Sulfolin bypass closed	166
D3	Sulphur mass balance: Base case + Jigs	167
D4	Sulphur mass balance: Base case + Dense medium cyclones	168
D5	Sulphur mass balance: Base case + Baths	169
D6	Sulphur mass balance: Base case + LARCODEMS	170
D7	Sulphur mass balance: Flexsorb/OxyClaus or Sulphuric Acid	171

LIST OF TABLES

Table		Page
3.1	Distribution of sulphur over product streams	40
4.1	Properties of inorganic groups	44
6.1	Characteristic performance data for baths	71
6.2	Operating parameters for various jigs	85
7.1	Summary of coal analyses performed in 1986	91
7.2	Summary of X-ray diffraction results of the 1986 samples	92
7.3	Results of washability tests and sulphur distribution analysis, 1995 samples	93
7.4	Results of screening and traditional coal analyses, 1995 samples	94
7.5	Sulphur removal benefits from liberation of pyrite, 1995 samples	95
7.6	Separation efficiencies selected for design cases	113
9.1	Cost estimation proportioning basis	125
9.2	Summary of capital and operating costs, R million	126
9.3	Net Present Value (NPV) of the scenarios, R million	128
9.4	Net Present Value (NPV) of coal replacement costs	134
9.5	NPV of scenarios, adjusted for complex life extension benefits, R million	134
A1	Efficiencies, Dense medium based separation technologies	146-7
A2	Efficiencies, Water-only based separation technologies	148
C1	Carbon mass balance calculations: Standard SSF	156
C2	Carbon mass balance calculations: Jigs	158
C3	Carbon mass balance calculations: Dense medium cyclones	160
C4	Carbon mass balance calculations: Baths	162
C5	Carbon mass balance calculations: LARCODEMS	164
E1	Finances and comparisons, summary	172
E2	Finances and comparisons, details	173
E3	Cost estimation summary	174
E4	Bath, Wemco plant, preliminary equipment list	175
E5	Bath, Drewboy plant, preliminary equipment list	176

E6	LARCODEMS plant, preliminary equipment list	177
E7	Baum-type jig plant, preliminary equipment list	178
E8	Batac-type jig plant, preliminary equipment list	179
E9	Materials Handling Section	180
E10	Cost calculation information for Wet Sulphuric Acid plant	181
E11	Cost calculation information for Flexsorb/OxyClaus plant	182
E12	NPV calculation, Jig plant	183
E13	NPV calculation, dense medium cyclones plant	184
E14	NPV calculation, LARCODEMS plant	185
E15	NPV calculation, Bath plant	186
E16	NPV calculation, Flexsorb/OxyClaus plant	187
E17	NPV calculation, Wet Sulphuric Acid plant	188
E18	NPV calculation, Wet Sulphuric Acid plant, IRR determination	189
E19	Coal cost escalation calculation, cash cost basis	190
E20	Coal cost escalation calculation, transfer cost basis	191
F1	Standards for the analysis of coal	192