Environmental assessment of base metal processing: a nickel refining case study

by P. Forbes*, H. von Blottnitz†, P. Gaylard†, and J.G. Petrie‡

Synopsis

Mining and metallurgical processing companies that have adopted the principles of good environmental management often find it difficult to carry out an environmental assessment that yields meaningful opportunities for improved performance. This topic was investigated by means of a case study of a South African Base Metal Refinery (BMR) producing primarily nickel. A process-based Life Cycle Assessment (LCA) was carried out on the refining process, with the environmental impacts related to the production of reagents and utilities forming part of the assessment. The life cycle inventory (LCI) was based on plant operating data spanning 31 months of production, from which a baseline environmental profile could be generated and interpreted to indicate the main sources of potential environmental impacts. Consequently, opportunities for improved environmental performance could be identified from the LCA model, which expressly related potential environmental liability to specific sub-processes in the assessed industrial operation. The on-site steam plant was found to be the primary source of potential environmental impacts in most of the impact categories considered. In closing, the paper discusses some of the limitations encountered in use of the LCA method.

Keywords: **life cycle assessment; LCA; life cycle inventory; LCI; base metal refinery; improved environmental performance; environmental management systems; nickel refining.**

Introduction

The processing of mined and beneficiated ores, concentrates or mattes to produce refined metallic products is an important step in the production of base metals such as zinc, copper and nickel. Despite increased recycling, as well as first tentative steps towards dematerialization of economic activity in industrialized countries, prospects are positive for continued growth in demand for these commodities (see, e.g. Williamson[1]). However, it is nowadays generally accepted that the extraction and processing of such resources has to be managed in a socially and environmentally responsible manner.

Petrie and Raimondo[2] have argued that improvements in environmental performance, whilst mostly driven by concerns expressed by society, can ultimately be effected only by the operating companies themselves. To this end, companies have to make use of technology change in a wider sense, extending beyond simple hardware choice to also include changes to operating and management practice.

One of the consequences of these realizations is the widespread adoption and implementation of Environmental Management Systems in many industries, including the mining and metallurgical sectors. Systems such as those based on the ISO 14000 standards by themselves do, however, offer little in the way of technical guidance to companies intent on improving their environmental performance. Consequently, the question often faced by management and technical staff is how an environmental assessment can be carried out so as to form the cornerstone for meaningful advances in this area.

Risk assessments of varying detail may be used for this purpose. However, the potential exists for emphasis to be placed on the most obvious, end-of-pipe aspects of a company's operations, which may in fact not always result in the most environmentally meaningful improvements. Life cycle assessment provides a broader view by generating a model which links the industry to be assessed through all its material and energy resource flows to other environmentally significant processes in the wider industrial network. At the same time a well-defined process life-cycle model retains the power to relate potential environmental liability directly to specific unit operations in the industry which is being assessed.

This paper reports on a process-based life cycle assessment which was performed for the

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Base Metal Refinery (BMR) of Impala Platinum Limited, situated in Gauteng, South Africa. The purpose of the study was to apply the theoretical framework for environmental assessment, as discussed above, in the metallurgical sector.

The industry assessed (the BMR) produces nickel, copper and cobalt from both platinum group metal (PGM) and non-PGM bearing materials. The environmental impacts associated with the production of these raw materials were excluded from the study, in order to focus on the impacts associated with the base metal refining operation itself, and to allow for flexibility of the results (a variety of base metal containing raw materials can be processed). Some of the minor reagents were also excluded from the study, as were the environmental impacts which can arise after the products leave the BMR site (that is, the study was conducted to the 'gate' only).

A number of LCA studies have been or are being initiated by the base metal refining industry, although the results remain largely unpublished. A large-scale LCI project is, however, being co-ordinated by the Nickel Development Institute, which will include data from approximately thirteen refineries[3].

A brief overview of process-based life cycle assessment

Life cycle assessments normally include the entire life cycle of a product or process, from the extraction and processing of raw materials, through manufacturing, transportation, and use; to final disposal. There are five main steps in performing a LCA[4]. Firstly, the *goal and scope* of the project must be identified and the functional unit defined, which 'describes the main function performed by a product (or process) and indicates how much of this function is considered'[4].

Data relating to the inputs and outputs of the process are then collected, in order to compile an *inventory*. The third step entails the selection of the environmental problems to be considered in the study (such as resource depletion and the greenhouse effect). Each item on the inventory list is then allocated to the relevant categories, using *classification* factors to relate the contributions of each substance to each environmental problem upon comparison to a reference substance. The environmental effects are then quantified to form an environmental profile by multiplying the amount of each substance by its relevant classification factor, and then adding up all the scores per environmental problem.

This environmental profile is then *evaluated*, and the effect of assumptions made on the results is determined. The processes which contribute significantly to the profile may then be identified and *improvement* opportunities noted.

In the following sections, the case study on the Impala Base Metal Refinery is discussed for each step of the LCA process.

Goal definition and scope

The main purpose of the study described here was to highlight areas of the base metal refining operations which contribute most significantly to potential environmental impacts, thereby identifying areas of potential improvement. The model developed is thus intended for use by Impala's management and process personnel.

System boundaries

The process of base metals refining generally involves the hydrometallurgical processing of mattes produced from the smelting of base metal-containing ores. In South Africa, sulphidic ores are mined, which contain both base and platinum group metals. A precious metal concentrate is produced after the base metals have been extracted from the matte, usually via multi-stage acidic leaching operations. Nickel, copper, and cobalt products are thus obtained after purification processes, which remove impurities such as iron (for example by jarosite precipitation) and selenium and tellurium. Sulphur is purged from the process via the production of ammonium or sodium sulphate as a by-product. The base metals are typically reduced electrolytically or by hydrogen.

The theoretical cradle-to-grave boundary of a LCA for the processing of sulphidic, precious metal bearing ores would have to include all of the processes from initial mining of the ore, through refining and value-adding operations, to use, recycling and final disposal of these products, as well as transportation steps. The material treated by the BMR is not confined to such precious metal bearing materials, however, and therefore a process-based system boundary, as shown in Figure 1, was used for the LCA. In this manner, the impacts associated directly with the BMR operations were focused on.

The BMR operations can be divided into three subsections, namely the refining process itself, steam generation, and hydrogen production, as shown in Figure 1. This division allows for improved transparency in the mass balances, and helps to clarify the audit trail of environmental impacts back to their sources in the process. Three types of flows are distinguished in Figure 1. Firstly, *standard flows* are those which interact directly with the environment, and thus have direct impacts. Examples include water usage and air emissions. *Closed loop flows* are 'internal' flows within the system considered (which have no environmental impacts directly associated with them), such as the steam flow between the steam generation sub-section and the BMR process sub-section. Finally, the environmental impacts of *open loop flows* were excluded from the assessment: examples are those associated with the products, and with reagents used in minor quantities (reagents (B) in Figure 1).

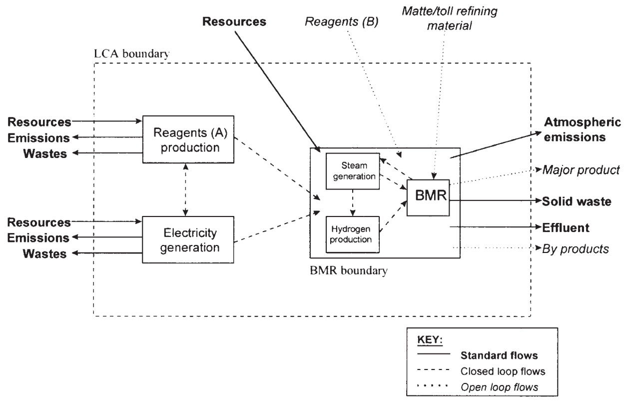

Figure 1—Process-based LCA boundary for the Base Metal Refinery of Impala Platinum Limited

The level of detail of the study and assumptions made

An average life cycle inventory (LCI) was generated from monthly production data spanning 31 months. Reagents which were used in relatively small quantities (≤ 0.03 t/t Ni produced, which equated to < 0.2% of the total inputs) were not included in the impact calculations, but were mentioned as a note to the inventory for completeness and to ensure that potential environmental impacts associated with these chemicals were not overlooked. A number of these reagents were later included in the LCI to determine the effect on the environmental profile in a sensitivity analysis, which validated their exclusion. Similarly, the exclusion of transportation of reagents to the BMR site was validated. The production and maintenance of capital equipment employed in the BMR was excluded, as was packaging (which is minimal). Air emissions from the BMR process itself, which could not currently be quantified, were excluded from the assessment.

The choice of functional unit

The primary products of the BMR are nickel, copper, and cobalt, with ammonium sulphate produced as a by-product. In addition, precious metal concentrate, selenium/tellurium residues, and ash are further processed by other operations. The functional unit was chosen as one ton of nickel produced, by virtue of the quantity of nickel production (approximately 70% by mass of the base metal output is nickel) and the revenue it generates (approximately 80% of the base metal revenue), as compared to the other products.

100% of the potential environmental impacts of the base metal refining process were thus ascribed to the nickel produced. Before benchmarking against the results of similar studies for other nickel producers, it will be essential to allocate portions of the impacts to by-products (such as the precious metal concentrate). Otherwise the environmental profile relating to Impala's nickel production might be portrayed as being unrealistically high.

Caution should also be exercised when drawing conclusions regarding the production of base metals as a whole, because (i) the potential environmental impacts associated with the production of the nickel-bearing raw materials processed by the BMR were excluded from this study, and (ii) the study was only extended to the gate of the BMR. *The results obtained and presented here are thus subject to the assumptions and limitations noted above, and they are also site and process specific.*

Life cycle inventory

Process flowsheet

As a first step, a suitable flowsheet which describes the unit operations of the BMR process was developed (refer to Figure 2) according to process flow, analytical data availability and by following considerations used in defining unit operations for the purpose of LCA[5]. The flow diagram thus developed facilitates the traceability of sub-processes which were perceived to have potentially significant environmental impacts (such as electricity consumption by the copper electrowinning operations).

Inputs and outputs

Monthly average operating data relating to Impala Platinum Ltd's BMR was collected for the period January 1995 to July 1997, inclusive, from which overall averages were calculated. These related to material inputs; inter-unit flows; production volumes; and other output quantities. The sources of the data, which included production records, purchase records, meter readings, metal accounting information, and theoretical calculations, were included in the database for traceability purposes. An overall error of 10 to 15% was estimated, based on the accuracy of measurements, and the monthly variations in the values.

The by-products were entered as 'open loop' outputs in the LCI, as they are used in downstream value-adding operations. Ammonium sulphate, for example, is sold as a fertiliser and the boiler ash is used by a brickworks. The jarosite waste is disposed of at a landfill site certified to accept and treat hazardous wastes. No potential environmental impacts (besides use of landfill volume) were thus ascribed to this waste. The liquid effluent is used by another company in the reclamation of disused slimes dams. A worst case scenario was employed here, in which the major base metal and anion components of the BMR effluent stream were assumed to seep through to groundwater, and thereby cause contamination of water systems. The rainwater which enters the pond was also included as a water input.

Inventories for reagents and utilities

The Pira Environmental Management System (PEMS) software package contains databases on materials manufacture, transportation, energy generation, and waste management[6]. Despite this data typically being from European sources, it was used to obtain LCI data for the

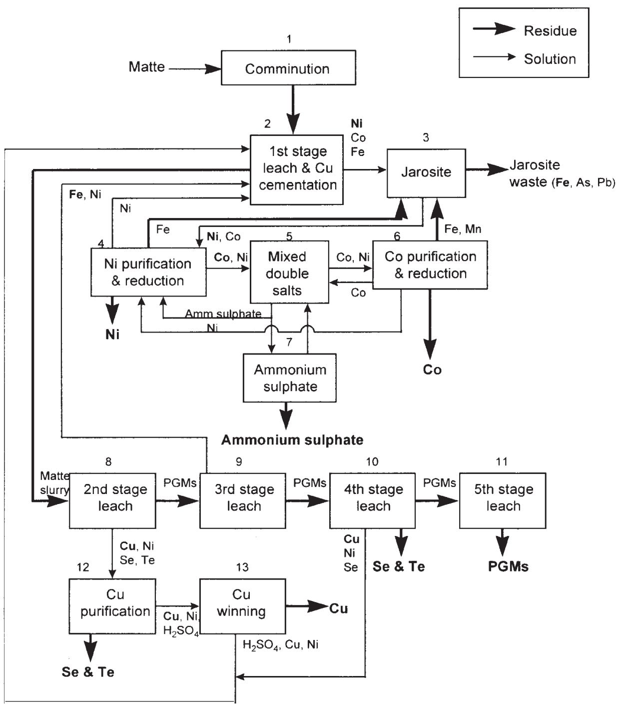

Figure 2—Simplified flow diagram for the Base Metal Refinery, showing unit operations as defined for the LCI

reagents used by the BMR process. In addition to this, a life cycle inventory for the generation of electricity from coal in the South African context was added to the databases in the PEMS software[7].

Method of calculation

The monthly consumptions of utilities and reagents were converted to usages per ton of nickel produced. The emissions associated with the generation or production of these inputs, which were relevant to the specific impact category, were then also related to the production of a ton of nickel, as illustrated in Table I, which shows an excerpt of the overall average inventory table.

In Table I, the inventory relating to steam generation has been separated into steam generation itself (the boiler operations on site) and coal mining (including coal washing operations). This was done in order to illustrate the type of data which is collected or calculated (that shown under steam generation), and that which has been obtained from an external data source (database inventory for coal mining). The BMR column, however, contains the summed totals of data from the BMR process itself, as well as that relating to the production of reagents used by the process (Reagents (A), such as ammonia, sulphuric acid, nitrogen, etc.), which was obtained from the PEMS database.

Classification and evaluation

During the classification process, the quantities of each substance are multiplied by classification factors, which relate the contribution of a substance to an environmental problem relative to a reference substance. The results pertaining to each problem category are then aggregated into effect scores to form an environmental profile.

Table I

Excerpt from the overall average monthly inventory table

Emissions (kg/t Ni)	Steam generation		Electricity generation	BMR
	Boiler	Coal mining		
Butane (unspecified)		0.006		
CO_2 (non renewable)	14368		6541	
CO_2 (renewable)			0.07	
CO_2 (unspecified)		391		2410
Dichloromethane				
Ethane		0.006		0.20
Halogenated HC (unspecified)				
Hexafluororethane				
HFC (unspecified)				
Methane		80	0.002	7.0
N_2O		0.17		
Non methane VOC (unspecified)		0.48		5.7
Pentane		0.006		
Propane		0.006		
Tetrafluoromethane				
Tetrafluoroethylene				
Trichloromethane				
VOC			25	
Xylene (unspecified)		0.006		
NO_x	228	2.0	21	8.0
Input quantity		**5600 kg/t Ni**	**24000 MJ/t Ni**	

Examples of the classification calculations for the greenhouse effect and smog impact categories are shown in Tables II and III, respectively, where the processes which were the main contributors to these impact categories, are included. These were the generation of electricity and steam from coal combustion.

Each of the emission quantities (per ton of nickel produced), as listed in Table I, are multiplied by the classification factor for that substance to give an impact score. These impact scores are added for each process as well as for the entire system. In this manner, the contribution of each process to the overall impact score may be assessed.

The information from the LCI was thus related to specific environmental concerns during the classification stage of the LCA. It was facilitated by the PEMS software, which contains information on a variety of environmental effects such as the depletion of non-renewable resources, acidification, and greenhouse warming potential as derived from Heijungs[4]. In this manner, contributions of individual substances to each problem were aggregated to form environmental profiles relating to the process as a whole, which could then be evaluated.

A 'water usage' impact category was added to the PEMS outputs, in order to indicate the consumption of water by the different processes. This was deemed necessary because water is a valuable commodity in South Africa as a result of what Middleton[8] has termed a 'maldistribution of demand and supply'. A further impact category that could have been defined because of its particular relevance to the South African scenario, is that of salinization of surface waters. This issue was, however, not addressed in the study, partly because classification factors for this impact would have to be defined first. A need for research and procedural development is noted in this regard.

The average baseline environmental profile for the production of one ton of nickel by the BMR of Impala Platinum Limited is given in Figure 3, in terms of percentage contributions of selected sub-processes to the total potential impact in the main categories of environmental concern. The use of coal (for both electricity and steam generation), Sasol gas (by the hydrogen plants), and resources used in reagent production (for the BMR process itself) all contributed to the resource depletion impact category, whilst water usage was primarily by the BMR and steam generation processes. The generation of carbon dioxide from combustion and hydrogen production reactions resulted in a contribution to global warming potential and other gaseous products from coal combustion have the potential to cause acidification of the environment as well as photochemical smog formation.

The effluent was the primary source of potential toxicity to aquatic ecosystems. The preparation of reagents, and the use of Sasol gas and coal also contributed to this impact category, as well as to the terrestrial ecotoxicity, ozone depletion and human toxicity scores. A number of the processes may contribute to enrichment of water sources by plant nutrients (notably by nitrogen and phosphorus), which is known as eutrophication or nutrification[9].

It must be noted that there is a degree of uncertainty in the classification process, which arises from the grouping of effects into impact categories and in the use of classification factors[10–13]

Table II

Excerpt from the greenhouse effect classification calculations

Emission	Class factor	Steam generation		Coal for steam			BMR		SA electricity		
		kg/t Ni	Impact score	kg/1000kg coal	kg/t Ni	Impact score	kg/t Ni	Impact score	kg/3600MJ	kg/t Ni	Impact score
CO_2 (non renew)	1	14368	14368						978	6541	6541
CO_2 (renew)	1								0.01	0.07	0.07
CO_2 (unspec)	1			69.8	391	391	2410	2410			
Dichloromethane	9										
Halogenated HC (unspec)	4										
Hexafluororethane	9200										
HFC (unspec)	1000										
Methane	21			14.3	80	1680	7.0	147	2.9E-04	0.002	0.04
N_2O	310			0.03	0.17	52					
Tetrafluoromethane	6500										
Tetrafluoroethylene	1300										
Trichloromethane	4										
Total (kg CO_2 per t Ni)			**14368**			**2123**		**2557**			**6541**

Note: Contributions to the greenhouse effect are expressed as kg CO_2 equivalent

Table III

Excerpt from the smog classification calculations

Emission	Class factor	Steam generation		Coal for steam			BMR		SA electricity		
		kg/t Ni	Impact score	kg/1000kg coal	kg/t Ni	Impact score	kg/t Ni	Impact score	kg/3600MJ	kg/t Ni	Impact score
Butane (unspec)	0.315			0.001	0.006	0.002					
Ethane	0.082			0.001	0.006	0.000	0.20	1.6E-02			
Methane	0.007			14.3	80	0.56			2.9E-04	0.002	1.3E-05
Non methane VOC (unspec)	0.416			0.086	0.48	0.20	5.7	2.4			
Pentane	0.352			0.001	0.006	0.002					
Propane	0.42			0.001	0.006	0.002					
VOC	0.377								3.69	25	9.3
Xylene (unspec)	0.849			0.001	0.006	0.005					
Total (kg ethene per t Ni)			**0.0**			**0.77**		**2.4**			**9.3**
NO_x	1	228	228	0.361	2.0	2.0	8.0	8.0	3.08	21	21
Total (kg NO_x per t Ni)			**228**			**2.0**		**8.0**			**21**

Note: Contributions to smog are expressed as kg ethene or kg NO_x equivalents

Improvement assessment

The environmental profile as shown in Figure 3 was used in conjunction with the LCI information, to identify dominant processes in terms of environmental impacts and thus potential areas of improvement.

Steam generation

The percentage contributions of the steam generation plant to total potential impacts were considerable for most of the impact categories, as shown in Table IV. It was also found that energy usage efficiencies were much less favourable at low nickel production rates, decreasing to half their normal value. This is a consequence of the fact that the BMR is a continuous operation with a large fixed energy load (due to the maintenance of vessel temperatures, providing agitation, and so on).

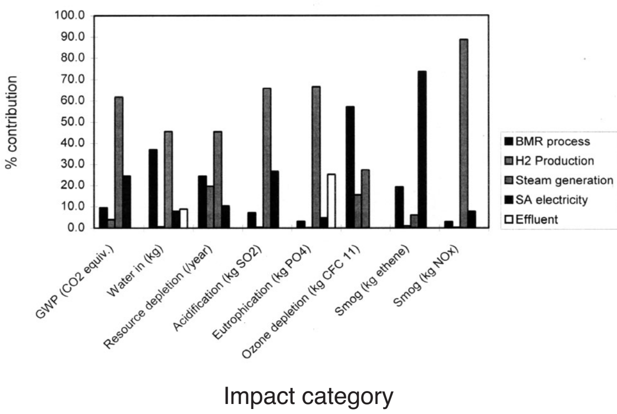

Figure 3—Percentage contributions of processes to the overall average impact assessment for Impala Platinum Ltd, BMR

Table IV

The contribution of steam generation and electricity usage to the overall average environmental profile

Impact category	% contribution from steam generation	% contribution from ELECTRICITY
GWP (kg CO_2)	62	25
Water in (kg)	46	8.0
Resource depletion (/year)	45	10
Acidification (kg SO_2)	66	27
Ecotoxicity (Aquatic m^3)	15	16
Ecotoxicity (Terrestrial m^3)	39	0.0
Eutrophication (kg PO_4)	67	4.8
Human Toxicity (kg/kg)	57	34
Ozone depletion (kg CFC 11)	27	0.0
Smog (kg ethene)	6	73
Smog (kg NO_x)	89	8.0

It was concluded that means of reducing the impacts associated with steam generation should be investigated. Measures in addition to improving steam usage efficiencies could include the use of good quality coal, or alternative fuels (oil or electricity); and the control of combustion parameters to reduce atmospheric emissions[14].

A large portion of the steam is lost through venting (around 50% of the steam used in the BMR process), thus the potential for recovery of steam is being investigated[15]. Most of the ammonia present in the flashed steam would also be removed from the vent gas, but the recovery of the ammonia in this solution would be uneconomical, although it could be recycled within the process. In this manner, emissions to the atmosphere would be reduced, and a decrease in water usage and a slight decrease in ammonia usage may result. In addition, steam generation from the hot condensate would require somewhat less energy, and thus less coal would need to be burned. Consequently, the environmental impacts per ton of nickel produced due to steam generation would decrease.

Further recommendations pertaining to steam generation were that the efficiency of the boilers should be optimized by improved measuring protocols (to verify the mass balance), and subsequent comparison with the performance of other, similar boiler operations. Steam usage efficiencies should also be critically evaluated, in order to reduce steam demand.

Electricity usage

Energy consumption is often a major factor in LCAs, due to the consumption of non-renewable resources, as well as the emissions associated with thermal power stations. Electricity generation contributed significantly to the human toxicity, greenhouse effect, acidification, aquatic ecotoxicity, and smog (ethene) impact scores, as is evident from the percentage contributions presented in Table IV. It was thus recommended that an effort be made to reduce electricity consumption where possible, in order to minimize these potential impacts, which would have the added benefit of reducing costs.

Reagent consumption

In terms of the BMR process itself, oxygen generation contributed the most to the water usage impact category (although this was a small percentage of the total water consumption). Ammonia production was the largest contributor of the reagents to most of the impact categories, with significant contributions to the resource depletion, terrestrial ecotoxicity, ozone depletion, and smog (ethene) impact scores. It was therefore recommended that attention be paid to the ammonia consumption by the BMR process so as to reduce these potential impacts associated with its production.

Limitations of LCA

In assessing the results of LCAs, the limitations of the method should be borne in mind, which include the following[16]:

- The quality of the study is limited by the data available, and the validity of any assumptions made. In the study presented here, data pertaining to on-site operations was diligently compiled and is deemed of exceptionally high-quality. Data pertaining to manufacture of reagents by other producers was sourced from the software vendor's database and has to be accepted as is
- Potential and not actual effects are considered
- Full LCA studies require a great deal of work, and therefore incur time and monetary costs. This can be confirmed for the study presented here, but the results obtained were deemed to justify the costs
- There is still a lack of relevant publicly accessible databases, (especially for applications which have not previously been explored by LCA).

Conclusions

LCA may be regarded as a potentially useful tool for the identification of opportunities for environmental improvement in industrial processes, as is illustrated by the study of the base metal refining operation presented here. It was shown that potential impacts may be substantially reduced by improving steam use efficiencies, as well as by optimizing steam generation, and electricity and ammonia consumption. Even when the inherent limitations regarding the LCA approach are taken into account, LCA is therefore considered useful in identifying improvement opportunities which may otherwise be overlooked in the presence of other more visible or well documented environmental aspects.

Acknowledgements

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References

1. WILLIAMSON, D. Into the next millennium—the long bull market in metals and minerals; *SME National Meeting*, Denver, Colorado, 1997.

2. Petrie, J.G. and Raimondo, J. Attempts to close material cycles in industrialised countries: Threat, challenge or opportunity for minerals exporting countries?; *Proceedings XX International Mineral Processing Congress*, Aachen, Germany. Hoberg, H. and von Blottnitz, H. (eds.) GDMB, Clausthal-Zellerfeld, 1997.
3. McKean, B. NiDI, Private communication, 05 June 1998.
4. Heijungs, R. (final editor), Environmental Life Cycle Assessment of Products—Guide, *Centre of Environmental Science*, Leiden, 1992.
5. Stewart, M. and Petrie, J. Design for pollution prevention in minerals processing-a life cycle assessment perspective, Presented at *CIM*, Montreal, Canada, 1996.
6. Pira International, PEMS version 4 User Manual, UK, March 1998.
7. Notten, P.J. The Role of Life Cycle Assessment in Achieving Effective Environmental Management in Coal-fired Power Generation, Ph.D. thesis (in progress), *Department of Chemical Engineering*, UCT, 1998.
8. Middleton, B. Water audit-the resource, the future, some solutions, *Water, Sewage and Effluent*, 18, (1), March/April 1998, pp. 20–22.
9. Harrison, R.M. (Ed), Pollution: Causes, Effects, and Control, 2nd edition, *The Royal Society of Chemistry*, Great Britain, 1990.
10. Barnthouse, L., Fava, J., Humphreys, K., Hunt, R., Liabson, L., Noesen, S., Norris, G., Owens, J., Todd, J., Vigon, B., Weitz, K., and Young, J. (eds), Evolution and development of the conceptual framework and methodology of life-cycle impact assessment, Addendum to *Life-Cycle Impact Assessment*: *The State-of-the-Art*, 2nd ed, SETAC, 1998.
11. Guinée, J.B. and Heijungs, R. A proposal for the classification of toxic substances within the framework of life cycle assessment of products, *Chemosphere*, 26, (10), 1993. pp. 1925–1944.
12. Owens, J.W. Life-cycle assessment: Constraints on moving from Inventory to Impact Assessment, *Journal of Industrial Ecology*, 1, (1), 1997. pp 37–49.
13. Owens, J.W. LCA impact assessment categories: Technical feasibility and accuracy, *Int. J. LCA*, 1, (3), 1996. pp. 151–158.
14. Noyes, R. Pollution Prevention Technology Handbook, *Noyes Publications*, USA, 1993.
15. Makwana, M. Sherritt International Corporation, Private communication with T. Spandiel, Impala, September 1996.
16. Jönson, G. LCA—A Tool for Measuring Environmental Performance, Pira, UK, 1996, pp. 50–53. ◆

Health and safety are paramount, says Barlows equipment*

Barlows Equipment's strong safety focus at Electra Mining Africa 2000 has culminated in the donation of contributions made by visitors to the stand to AIDS research and education in the coal industry.

Visitors to the Barlows stand were asked to contribute towards health issues in the industry in return for promotional items on the stand and Barlows Equipment is to double this contribution. John Kaplan, exhibition director of Electra Mining, has also pledged a donation on behalf of his company, Specialised Exhibitions.

The total sum involved is in the region of R30 000.

At a ceremony at the Barlows stand at Nasrec, Lester Day, Barlows Equipment managing director, made the presentation to Bielie van Zyl, chairman of Coaltech 2020. (Van Zyl is vice president, Environment and Rehabilitation, at Anglo Coal.)

'Coaltech 2020 is a research body sponsored by coal mining companies as well as Eskom, the CSIR and the Department of Trade and Industry to ensure the success of the South African coal industry to the year 2020 and beyond,' explains van Zyl.

'An important aspect of this research is the impact of AIDS on the industry, including the implementation of ongoing education and awareness programmes, which is the subject of a study by the Mpumalanga Power Belt AIDS project under the auspices of Coaltech 2020.'

'Operator safety, evidenced by our truck operator training simulator, has been our overriding theme at Electra Mining,' says Barlows' Lester Day. 'Safety and health are closely linked and we believe that by raising awareness of health issues including AIDS, the mining industry will be protecting its skills.

'In a society with scarce resources we can ill afford to train people who do not have long term health prospects. The top level training required to ensure safety on today's high-tech mines is expensive and the people who receive that training are extremely valuable to the industry.'

Says John Kaplan: 'Specialized Exhibitions, aware that AIDS is a major issue in the mining sector, congratulates Barlows Equipment for taking the initiative and giving something back to the industry. We are proud to contribute to the work being done by Coaltech 2020.' ◆

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Annual Conference: Mineral Processing 2000*

The nineteenth annual conference, Minerals Processing 2000, organized by the Werstern Cap Branch of the South African Institute of Mining and Metallurgy, was held at the President Hotel, Bantry Bay on 24th and 25th August 2000.

The Conference was preceded, on 23rd August, by a very successful one-day workshop entitled 'Developments in Non-Ferrous Pyrometallurgy', which was attended by 70 delegates. The Workshop was chaired by DR Sharif Jahanshahi, Manager-Base Metal Pyrometallurgy at the G.K. Williams Co-operative Research Centre in Melbourne, and speakers included representatives form industry, furnace, designers, universities and research organizations. At the conclusion of the Workshop, delegates travelled to the Department of Chemical Engineering at the University of Stellenbosch, for the formal opening of their new Pyrometallurgy Research Laboratory.

In his speech at the opening, the Dean of the Faculty of Engineering at the University of Stellenbosch, Professor P.W. van der Walt, pointed out that South Africa traditionally has suffered from a shortage of engineers, particularly in the area of extractive metallurgy. To address this, the chemical engineering departments of the Universities of Stellenbosch and Cape Town, and the Cape Technikon established the Western Cape Mineral Processing Facility (or WCMPF), as a joint venture, to train the students in the practical aspects of mineral processing. This collaboration led to more efficient use of resources (both human and infrastructural), with less duplication of equipment, making the expansion of a single, joint facility easier. Because of space limitations at the other institutions, it was decided to develop the existing pyrometallurgical laboratory at the University of Stellenbosch into a facility that could meet the demands of industry and modern research.

The Pyrometallurgical Research Laboratory has furnaces with programmable temperature controls for conducting experiments up to 1800°C, under controlled has atmospheres, including tube and muffle furnaces, a TGA instrumental furnace, an induction furnace and a DC plasma-arc furnace, which was funded by the WCMPF. Supporting facilities include thermal gravimetric analysis and a wide range of analytical services, including x-ray diffraction, x-ray fluorescence, inductively coupled plasma and wet chemical analysis, scanning electron microscopy, and electron microtrone analysis.

The facility was established with the aim of complementing similar facilities available at the Universities of the Witwatersrand and Pretoria, to increase the total output of students with a pyrometallurgical background, and to enhance the total pyrometallurgical research capability within South Africa. The facility is also expected to meet the future demand for pyrometallurgical research arising from the increasing extractive metallurgical activity in the Western and Northern Cape.

Professor van der Walt thanked all the sponsoring organizations, namely The Anglo American Chairman's Fund, Anglo American Platinum Corporation, Anglovaal Mining, Crusader Systems, The Atomic Energy Corporation of South Africa, The Department of Trade and Industry (via THRIP), Mintek and the Universities of Cape Town and Stellenbosch, for their generous support, which has made the establishment of the facility possible.

There were more than 200 delegates registered for the Minerals Processing 2000 Conference and, over the two days, 44 papers were presented in ten separate sessions, covering comminution, flotation, pyrometallurgy, hydro metallurgy, copper processing, process control, and the environment. Speakers included representatives from industry, from research organizations and from various tertiary institutions, including two Australian Universities and the University of Zambia. There were also 25 poster presentations.

Highlights of the Conference included the plenary lectures, by Mr. L. Delport, Operations Manager-North of Namakwa Sands, on the first day, and by Dr E. Manlapig, of the Julius Kruttschnitt Mineral Research Centre at the University of Queensland in Brisbane, Australia, on the second day of the Conference. Mr Delport's lecture, 'Namakwa Sands-from Drawing Board to Reality' provided a fascinating glimpse of the technical problems, which had to be solved before Namakwa Sands could become a commercially successful operation. In his lecture, 'Challenges in the Scale-up of Mineral Processing Plants', Dr Manlapig discussed scale-up methodologies, using case studies and examples in comminution and flotation to show how they may be used effectively, and proposed a procedure for designing machines that can be expected to perform as predicted.

We were pleased to welcome Mr Mike Rogers, Immediate Past President of the SAIMM, at the conference dinner. He presented the Institute prizes to the outstanding mineral processing students from the three Western Cape tertiary institutions in 1999, and, in a brief address, informed the delegates about the recent activities of the Institute.

The Conference was generously sponsored by Metallurgy Automation, Afrox, Foskor, Hatch Africa, Namakwa Sands and Senmin, enabling the Branch to cover the cost of student participation in the proceedings. In addition, the success of the Conference was assured by the strong support it received from the delegates who attended, particularly those from the minerals industry. To them, and to the sponsors, the Branch extends its sincere thanks. ◆

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