Abstract

The Mt. Newman Mining Co. Pty. Limited Beneficiation Plant at Newman has been in operation for more than four years.

The plant was designed to process 6.8 Mtpa (Million ton per annum) of “contact ore” which is a mixture of high grade hematite and shale produced during the normal course of mining.

This contact ore cannot be utilized as part of the overall blend because of its high alumina, average 4.3% and low iron content, average 55%. The Plant was designed to produce 5.2 Mtpa of high grade products. This represents only a small percentage of the total project capacity of approximately 40 Mtpa.

This paper outlines the metallurgical testwork performed and the decisions taken in evolving the process of the Newman Beneficiation Plant.

The basic layout of the Beneficiation Plant is discussed with particular reference to the Control System for its fully automated operation.

As commissioning of the Plant has taken place over an extended period, the paper also reviews improvements and plant modifications which have occurred as well as presenting information concerning current operations.

The paper briefly summarizes the reasons why the design capacity, although achievable in the short term, has not been met in the long term.

Introduction

The Mt. Newman Mining Co. Pty. Limited Beneficiation Plant at Newman in Western Australia treats low grade iron ore mined from the Mt. Whaleback Mine and separates high grade hematite from shale. The separation is performed using the principles of Heavy Medium and Wet Gravity techniques. Effective separation is obtained due to the high density hematite (SG \textgreater{} 4.0) and the relatively low density ferruginous shales (SG \textless{} 2.6) with minimal near gravity material present between this large gravity differential.

The primary need for the Beneficiation Plant arose due to the large tonnage of medium and low grade ores which were being produced during the general course of mining of Mt. Whaleback. To maintain shipping grade targets these ores were being directed to low grade stockpiles or to waste dumps.

The predominant source of these medium and low grade ores occurred during the mining of the contact between high grade ore and adjacent shale. This mixture of high grade hematite and shale is referred to as “contact ore” and is used as feed to the Beneficiation Plant. Processing of this material to recover the high grade hematite has extended the high grade ore reserves of Mt. Whaleback by some 145 million tonnes.

The Beneficiation Plant also satisfies the commitment for secondary processing of iron ore as detailed in the initial guidelines agreed with the Western Australian Government in the “Iron Ore (Mt. Newman) Agreement Act, 1964–1967”.

* 昭和58年11月15日本会第71回例会において発表
** Superintendent Ore Processing, Mt. Newman Mining Co. Pty. Limited, Newman, Western Australia

昭和58年9月14日受理
The Beneficiation Plant was designed to produce 5.2 Mtpa of high grade products. Although this represents only a small percentage (13%) of the total project capacity of about 40 Mtpa, the Plant has a high commitment to produce. The Plant is capable of producing shipping grade material but also has the capability of producing flexible grades to satisfy "as railed" grade requirements.

**Initial Test Work**

**SAMPLES**

Commencing early in 1975, 5,000 to 10,000 tonne bulk samples of low grade contact ore were processed, through the Number 1 High Grade Crushing Plant at Newman, to collect sub samples for metallurgical testing to evaluate potential beneficiation techniques.

As the samples had been primary and secondary crushed the material was nominally —100 mm in size with a decreasing iron content from the coarsest fractions to the finest. In the Mt. Whaleback deposit the shales are much softer than the hematite ore.

Early in the testwork programme it became evident that good liberation of the valuable iron minerals existed over the complete size range. All ore fractions exhibited minimal near gravity material between the high density hematite and the low density shales. The absence of any composite hematite/shale particles indicated that sharp separations would be possible with processes relying on a density differential.

**LUMP ORE (−100+6 mm Material)**

For this coarse ore, Erickson Cone studies indicated that Heavy Media separation in a Wemco Drum (static bath vessel) would be most appropriate. The nature of the ore was such that coarse and medium drums were not required and that separation could be conducted at a single specific gravity over the entire 100 × 6 mm particle size range. The Erickson Cone tests were conducted over the SG range 2.7–3.3, with the average results of these tests shown in Table 1.

The tests indicated that the best SG range of separation was 2.75 to 3.15, with the optimum
recovery from all contact feed ores at 3.0 SG giving 83.3% weight recovery, 92.9% iron recovery and producing 65.0% Fe product.

INTERMEDIATE FINE ORE (−6+1 mm Material)

For this intermediate ore, heavy media separation in dynamic separatory vessels such as the DSM Cyclone and Dyna Whirlpool (DWP) unit was investigated. Whilst it is possible to process ore down to 0.5 mm in such vessels, consumption of heavy medium is high with the smaller particles and it was decided to apply a cut off at 1 mm to minimize operating costs in the overall plant complex. The test work involved heavy liquid tests, computer predicted performances, a pilot plant Heavy Medium 350 mm DSM Cyclone (Mitchell Cotts Mark 4 Unit) and pilot plant trials with a 150 mm Dyna Whirlpool unit.

Table 2, gives a comparison of some of the test work results between the Cyclone and DWP performances with −10+0.5 mm material at 56.5% Fe and 4.7% Al₂O₃.

The tests showed that the iron recoveries with the Cylcone were far superior to the DWP. On the basis of these testwork performances the DSM Cyclone was selected for the plant to treat the −6+1 mm material.

The tests indicated that the Cyclone circuit operating at 2.6 to 2.7 SG would give optimum recoveries of all contact feed resulting in 85.3% weight recovery, 95.8% iron recovery and producing 61.7% Fe product.

FINE ORE (−1 mm Material)

For this fine ore a number of processing methods were considered including classification by

Table 2

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<tr>
<th>Medium</th>
<th>DWP</th>
<th>Cyclone</th>
<th>DWP</th>
<th>Cyclone</th>
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<td>61.7</td>
<td>82.7</td>
<td>69.5</td>
<td>93.1</td>
</tr>
</tbody>
</table>

Table 3
Review of Operations Iron Ore Beneficiation Plant

water-only cyclone, gravity separation by Reichert Cones and spirals, and wet high intensity magnetic separation (WHIMS). With the Reichert Cone, spirals and WHIMS techniques, desliming of the —1 mm feed near 0.06 mm is required. Flotation of slimes was not considered as very little recovery would be achieved in practice.

A comparison of the results for the different techniques tested for beneficiating the fine ore fraction is shown in Table 3.

The Water-only Cyclone achieved a product grade of 61.6% Fe but due to the weight and iron recoveries being extremely low this technique was considered unsuitable for processing contact ore.

The Spiral Concentrator produced satisfactory results but as it is a low capacity unit it was rejected in favour of the Reichert Cone.

Both the Jones and Readings WHIMS units produced satisfactory results, with the Readings unit capable of better performance than the Jones unit. The Reichert Cone results were also satisfactory, being similar to the Readings WHIMS, and had the test feed to the cone been —0.5 mm instead of —1.0 mm, then the recoveries would have been even higher.

Advantages of the Reichert Cone versus WHIMS were seen as:
(1) Reduced capital cost for installation of the fine ore circuit and a lower overall operating cost.
(2) Flexibility to treat particles up to 1.2 mm in size. Feed to the WHIMS is restricted to 0.8 mm due to space restrictions within the plate gap (2.5 mm). This facility to treat —1.2+0.8 mm material would remove it from the heavy medium cyclones circuit, reducing medium losses and hence operating costs.

Based on the above results and observations of all the techniques considered, the Reichert Cones were selected as the most appropriate means of producing high grade fines from the Fine Ore Fraction.

The tests indicated that the Reichert Cones would give good recoveries from contact feed resulting in 76.5% weight recovery, 86% iron recovery and producing 61.7% Fe product.

Beneficiation Plant Process

BASIS FOR DESIGN:

The design parameters for the Beneficiation Plant process were:

Feed: 6.8 Mtpa averaging 55% Fe (Range 46 to 63.5% Fe)
Products: 5.2 Mtpa averaging 63.6% Fe
Waste: 1.1 Mtpa solid waste at 25% Fe
0.5 Mtpa slimes waste at 33% Fe
Weight Recovery: 76.5%
Iron Recovery: 88.3%

Feed for the Beneficiation Plant would come direct from shovels mining contact ore, a limited buffer stockpile adjacent to the Primary Crusher and from low grade stockpiles built prior to June 1979.

The Plant was designed for continuous operation: seven days per week, 24 hours per day and an estimated available 6,000 operating hours per year.

CRUSHING AND SCREENING

Contact feed ore is Primary Crushed (Allis Chalmers, 60–89 Gyratory Crusher) to minus 150 mm, Secondary Crushed (Allis Chalmers, 17–84 Hydrocone Crusher) to minus 100 mm and Dry Screened
(three Allis Chalmers 20×8 RIPL FLO Screens) to produce Lump Ore (−100+6 mm) and Fines Ore (−6 mm). The Lump Ore is conveyed to the Heavy Medium Drum Plant surge bins, whereas the Fine Ore is Wet Screened (three Allis Chalmers 20×8 Low Head Screens) at 1 mm to produce

**Figure 2.** Grade and Tonnage Distribution for Mt. Whaleback Contact Ore

**Figure 3.** Crushing and Screening Ore Flow
Intermediate Fines (−6+1 mm), conveyed to the Heavy Medium Cyclone Plant surge bin and a Fines Slurry (−1 mm) which is pumped to the desliming cyclones and thence to the Reichert Cones Plant.

**CONCENTRATOR**

**Drum Plants**

There are two modules of Wemco Drum Separators. Each Wemco Drum is 4.25 m in diameter and 3.75 m in length.

The lump ore (−100+6 mm) is wet screened to remove any remaining −6 mm fines which after dewatering are conveyed to the Cyclone Plant. The lump ore then mixes with the heavy medium, a slurry of ferrosilicon and magnetite, and is separated, in the Wemco Drum, into high grade sinks (hematite) and low grade floats (ferruginous shale) at a separating density of 3.0. The sinks and floats are then washed to recover the heavy medium and join common product and waste conveyors respectively. Recovery and cleaning of the medium is via two stages of wet countercurrent magnetic separators.

**Cyclone Plant**

The intermediate fines feed (−6+1 mm) is wet screened to remove any remaining −1 mm material, which is washed into the Reichert Cones Plant.

The fines feed then mixes with the heavy medium, a slurry of ferrosilicon and magnetite, and is gravity fed to nine DSM cyclones. A separating density of 2.7 results in a high grade sinks underflow (hematite) and a low grade floats overflow (ferruginous shales). Both sinks and floats are washed to recover the heavy medium.

The sinks are conveyed to a twelve compartment zonal dewatering bunker for approximately four hours to remove free draining water and then join the common product conveyor, whilst the floats join the common waste conveyor. Again medium recovery is via two stages of wet magnetic separation.

![Figure 4. Concentrator Ore Flow](image-url)
Reichert Cones Plant

The fines feed (-1 mm) from the Wet Screening and Cyclone Plants is pumped to a bank of 22 AKW hydrocyclones to remove -0.063 mm slimes which gravitate to a thickener.

The -1+0.063 mm underflow then passes through the Reichert Cones configuration: a bank of eight 4DSV Reichert Cone concentrators comprising three primary, two cleaner and three scavenger stacks. Both the high grade concentrate (hematite) and low grade tails (ferruginous shales) are dewatered by cyclones then dewatering screens and join the common product and waste conveyors respectively.

Tailings Disposal

The -0.063 mm slimes are laundered to a 91 m diameter Dorr Oliver centre drive caison type thickener. The overflow from the thickener passes to a clarified water tank for reuse as plant process water whilst the underflow is disposed of by pumping 3.5 km to slimes dams. Water recovered from the slimes dams is used for dust suppression on the Mt. Whaleback mine haul roads.

Automatic Control System

OPERATING PHILOSOPHY

Perhaps the most significant difference between the Beneficiation Plant and other similar plants is the degree of automation of the process control. All processes and sequences throughout the Plant are co-ordinated from the central control room. Except for limited local testing, manual operation is virtually impossible.

The reasons for this commitment include:

(1) Wet process plants give best availability and throughput with steady state conditions. The automatic control system provides the basis for steady state operating conditions by considering the status of process and surge capacities, both upstream and downstream of any section.

(2) Experience in other wet plants had shown that if an option to operate the plant in auto or manual mode was available then the latter would normally be selected by plant operators. This would result in neglect of the auto system to the extent that when required it would not work.

(3) Manning levels in the Plant had to be minimized if the operation was to be economic.

(4) Sequence control had previously been effective using Programmable Logic Controllers within the crushing and screening operations at Port Hedland. Mt. Newman Mining Co. Pty. Limited was equipped for, and committed to, this technology which offered distinct advantages over both relay logic systems or computer control.

There was little doubt that fully automatic sequence control of conveyors, screening and crushing would work, however, the main challenge was in automating the wet metallurgical processes.

CONTROL SYSTEMS

The total control system consists of four general areas which may be independent or interacting. These are the Digital Control System (PLC), Analogue Control System (TDC), Data Logger System (Computer) and a Communications System. Figure 5 indicates how the control systems interact with each other and with the control room operator.

Digital Control Systems

The automatic sequence start-up/shutdown and fault shutdown is controlled using General Electric Programmeable Logic Controllers (PLC's). There are nine of these microprocessor based systems, each one controlling a relatively discreet area. The distribution of modules means that the
failure of any one does not have a plant wide effect. A spare unit is also available and may be loaded with the programme of any of the areas via magnetic tape. The PLC's may also be programmed in standard electrical symbols via a keyboard display and stored in the CPU. The status of any relay or field device can be determined at any stage knowing the identity of that point.

With training, shift electricians are able to use the display as a powerful fault finding tool. In addition the sequence logic may be altered by key access and, where devices are faulty, over-ridden without need to access the device or the relay it drives. The sequence logic may also be changed to more closely meet production or maintenance requirements.

As electrical supervision can make these changes it obviates the need for a software expert as in computer based systems. This system has proved to be more flexible and easier to diagnose than relay logic.

From the operating point of view, an automatic sequencing system eliminates the majority of manual repetitive operations. The fact that the plant should always start up or shut down in a certain order allows the operators to pinpoint more rapidly a problem area when the sequence is not followed.

Analogue Control System

Analogue process variables are controlled by a microprocessor based Honeywell TDC 2000 control system. Process variables are continuously monitored using field devices such as sump level transducers, nucleonic density gauges, magnetic flowmeters and belt weighers. Each control loop could be configured as manual, automatic cascaded with other control loops or run in computer control.

All control loops are displayed in bar chart and numerical form indicating process variables, set point and output on a colour CRT screen. Three options are available through the operator key board: an overview of the whole plant, any group of eight loops or any single loop. Any loop may be
driven in manual but the console will indicate if that loop is in a mode of operation other than its normal one. Although the TDC system is located in the control building remote from the process, it is still a distributed system and has a substantial amount of redundancy. The micro-processor based control loops are organised in groups of eight and any group can be re-programmed and re-connected to perform the task of any other group. Re-programming is via a cassette tape unit.

In addition to the microprocessor based control, nine critical control loops can be controlled via traditional PID controllers on the control desk. This is to cater for a total system failure and is not intended for extended use.

Data Logger System
A Honeywell H716 computer and 2 x 0.5 Megaword disc units provides the plant Data Logging System in addition to restricted production logging and running times recording. With the CRT display the operator may select a variety of displays and run and determine the status of some 3500 digital points throughout the plant. An alarm display indicates the last 18 alarms to have been raised in the plant and new alarms are added within five seconds of occurrence. Up to 250 simplified diagrams of the plant may be composed and labelled with the current information on status of drives and current rate of process variables within the area being monitored. This is the only operating mimic system in the plant.

The underlying concept in the use of the computer displays is to have all information available in detail, but only to display that information which the operator specifically requests at any one time. The only exception to this is the alarm logger printer which continues to generate a hard copy of new alarms irrespective of what displays the operator has called.

Communications System
The Communication System is comprised of a FEMCO paging and two channel handpiece conversation set through which all verbal communications throughout the plant are conducted. In addition, sixteen closed circuit television cameras, most equipped with pan, tilt and zoom facilities are provided. These are remotely operated from the control desk and provide visual information to the Control Room Operator of unmanned or distant areas.

Commissioning
Commissioning of the Beneficiation Plant has taken place over an extended period. Although it was clearly evident at a very early stage that the Plant could perform well metallurgically by achieving separation of the hematite and shales, many bottlenecks and barriers to achieving design production levels were soon highlighted.

DESIGN DEFICIENCIES
Major bottlenecks included:

(1) The initial programmable logic in the computerized control system was very restrictive being designed for maximum power saving. Total plant start up was often prevented by a single minor fault in only one section of the plant. When running, this fault would often initiate total plant shutdown. Plant field devices were often unreliable and were tied into the control system for non critical, minor faults.

(2) Insufficient capacity in many areas including Reichert Cones plant dewatering, slimes and waste handling system, dewatering bunkers and some key conveyors.
(3) Incorrect selection of wear materials on components and pipework throughout the concentrator resulting in premature and often catastrophic failure.

(4) The need for more operating and maintenance personnel as well as more detailed training requirements, particularly in the area of rapid fault finding.

(5) Excessive spillage and blockages in the material handling systems due to problems associated with wet material.

(6) The non modular design of the plants severely restricted maintenance access and often meant that the entire operation needed to be stopped in order to provide access to a single area.

(7) Insufficient surge capacities throughout the Plant to cope with the variable nature of the contact ore feed material.

(8) Difficulty in handling fine, low grade feeds which caused reduced throughput rates and blockages/overload problems.

PLANT MODIFICATIONS

The bottlenecks above prevented steady state operations. The following changes to the original design have resulted in more efficient operations:

(1) The programmable logic sequence was rewritten to allow a more flexible operation whilst still maintaining the integrity of the safety and energy conservation aspects of the original philosophy. The changes were essentially a move from series type logic to parallel type logic such that not only could each plant start up independently but sections of each plant as well.

(2) Field sensing devices which were not critical to the process were removed from the logic for each plant stopping sequence. Unreliable devices were replaced with heavier duty components and in locations where the device gave more delays than the problem it was trying to detect. The devices were scrapped altogether.

(3) Installation of a third product dewatering cyclone and screen in the Cones Plant.

(4) Increased slimes pumping capacity.

(5) Upgrading of the solid waste stacking system.

(6) Upgrading of several key conveyors.

(7) Control Logic modifications to allow the operation of either or both Drum Plants and bypass facilities for both the Cyclone and Cones Plants have allowed greater maintenance and operating flexibilities. These bypass facilities are to allow short term maintenance access without the need to stop the entire Plant. This bypassing of Cones and Cyclone Plant feed material directly to product only occurs when the grade of the incoming feed permits.

(8) Installation of a Slimes Line flushing system.

(9) A larger stockpile of feed material prior to the Primary Crusher has allowed some blending of the contact ore and hence reduced problems associated with handling fine, low grade material.

(10) Changes to the Densifier Pump feed in the Drum Plants have resulted in less blockages and wear in the densifiers, reduced the number in operation from six to four and allowed a reduction in pump speeds.

(11) The redesign of some chutes and pipework, and improved conveyor belt scraping/washing has reduced blockages and spillage.

(12) Additional maintenance manning, the implementation of procedures to predict component life and the use of improved wear materials has reduced maintenance downtime.
(13) The implementation of a detailed training programme for both operating and maintenance personnel.

(14) Trend recording facilities in the control room.

**Metallurgical Performance**

The original design parameters for the Beneficiation Plant indicate a total product averaging 63.6% Fe, consisting of 65.0% Fe lumps and 61.7% Fe fines. (Refer Figure 2).

Figure 6 shows a simplified mass balance and grades for OY 14 (April 1982–March 1983). Overall it can be seen that the product when compared to the feed material has:

- Higher Fe
- Reduced SiO₂
- Reduced Al₂O₃
- Slightly reduced P (mostly in lump)

Other comments related to the metallurgical performance are:

1. Although the original test work indicated only 6% of feed material would report to slimes (−0.063 mm), the actual amount is closer to 12%.
2. Overall moisture content of the combined product is 6.6%.
3. The lump (+6 mm) to fine (−6 mm) ratio is high at 63%. After tertiary crushing the ratio is still high at 55%.
4. Ultrasizes content (−0.150 mm) of the fines product is only 15% with most being near size material. The fines product contains only 5.5% of −0.063 mm material.
5. The slimes show a fairly high Fe content as nearly all of the −0.063 mm is rejected.
6. Due to the nature of the OY 14 Feed material both iron recovery (83.4%) and weight recovery

![Figure 6. OY 14 Simplified Mass Balance and Grades](image-url)
(72.7%) were lower than the original design parameters. Total product averaged 63.9% Fe, consisting of 64.9% Fe lumps and 62.2% Fe fines.

**Heavy Medium Performance**

The original design expectation was to operate the Heavy Medium Drum Plants at 2.75 to 3.15 SG and the Heavy Medium Cyclone Plant at 2.50 to 2.85 SG. The Drum circuits would use a mixture of atomized ferrosilicon (Hoechst Cyclone 60 grade) and magnetite whilst the Cyclone circuit would use a mixture of milled ferrosilicon (Hoechst 270D grade) and magnetite.

Initial operations saw 100% ferrosilicon of the above grade being used in the Drum and Cyclone Plant at 3.0 and 2.7 separating SG respectively. Medium consumption was very high, with catastrophic losses due to logic sequence problems and the start/stop operations of the plants.

The last four years have seen many changes not only to the medium circuits, but also to the medium type and grades. The major medium changes have been:

1. The change over from atomized to milled ferrosilicon for Drum Plants due to the large cost differential.
2. Changes to coarser grades of ferrosilicon and magnetite with consumption benefits.
3. Decreases in the percentage of ferrosilicon to magnetite ratios for economic advantages.

Table 4 shows the medium consumption levels for both the Drum and Cyclone Plants.

Current operations are such that the Drum Plants are operated at 2.9 to 3.1 SG using mixture of milled ferrosilicon (Hoechst 65D grade) and magnetite whilst the Cyclone Plant is operated at 2.7 to 2.9 SG using a mixture of milled ferrosilicon (Hoechst 270D grade) and magnetite. Cyclone Plant ferrosilicon is soon to be changed over to the coarser Hoechst 150D grade.

In summary, the decreases in consumptions, not only reflect the increasing efficiency of operating the Beneficiation Plant, but can also be attributed to the following modifications and changes:

1. Computer control sequence changes.
2. Better washing on screens by using process water flood boxes, screen tiles, weir bar and side clamping bar changes and better spray nozzle arrangements and pressures.
3. Using more effective medium corrosion inhibitors, e.g., sodium nitrite.
4. Drum Plant densifier pump changes.
5. Densifier arrangements and control modifications.
6. Magnetic Separator spigot adjustments and overall "fine tuning" and policing of magnetic separator operations.
7. More field devices to pick up problem areas; especially doppler flow gauges.

**Table 4**

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<td>Medium Consumption (kg/t Feed)</td>
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* OY 12—Ore Year 12 i.e, April 1980—March 1981
(8) Coarser grades of medium in use.
(9) The installation of overflow, boil boxes and meshes in mixing launders and circulating medium sumps.
(10) Modifications to Cyclone spigots, liners and operating pressures.
(11) Pump speed changes.

Another factor incorporated in the original design, was the automatic medium addition facility, which not only saves operational labour and time but has definite advantages in medium consumption. These facilities, one for each of the Cyclone Plant and Drum Plants, provide bulk storage of medium, 120 tonnes of ferrosilicon and 50 tonnes of magnetite, which can be charged into the system as required via an agitated tank, pump and densifying cyclone. The loading of the medium into the bulk bins, from two tonne bulker bags, is performed only one day per month using overhead cranes and a forklift.

By using this addition system, losses are minimized as the medium is charged directly into the circulating system at the required density, and is completely ‘wetted’.

PRESENT PLANT CAPACITY

As mentioned previously, the original design capacity of the Beneficiation Plant was to produce 5.2 Mtpa of product from 6.8 Mtpa of feed.

This design capacity, although able to be satisfied or exceeded in the short term (8 hour shift, day or week), has proved virtually impossible to achieve in the longer term (month or year).

After the first two years of operation the capabilities of the Beneficiation Plant, in the same configuration as exists now, was down rated to 4.2 Mtpa of product from 5.4 Mtpa of feed.

This down rating was primarily due to:
(1) Insufficient intraplant surge capacity to cope with the variable nature, both chemical and physical, of the contact ore feed material.
(2) Lack of a surge pile of primary crushed feed material to both reduce interaction losses between the mining operation and the Beneficiation Plant operations and to provide some blending of the contact ore.

Solutions to (1) and (2) above require large capital expenditure and are difficult to justify during periods of reduced iron ore demand and when the Mt. Whaleback operation is operating at only 60% of its installed capacity.

The present target operating level is for 3.6 Mtpa of product from 4.66 Mtpa of feed. This further reduced operating level reflects the direct effects of the reduced iron ore demand: less iron ore is required and hence being mined which results in a reduction in the amount of contact ore being generated.

Conclusions

There is an ongoing commitment to continue the improvements in Beneficiation Plant performance with the emphasis on satisfying production requirements while reducing overall operating costs.

The Beneficiation Plant has proved to be effective in utilizing low grade iron ores and thus extending the ore reserves of Mt. Whaleback.

The Beneficiation Plant has become an integral component in the overall Quality Control System of the Mt. Newman Mining Co. Pty. Limited operation.
Acknowledgements

The author wishes to thank Mr. John Groves, Beneficiation Plant Production Supervisor, for his assistance in preparing this paper.