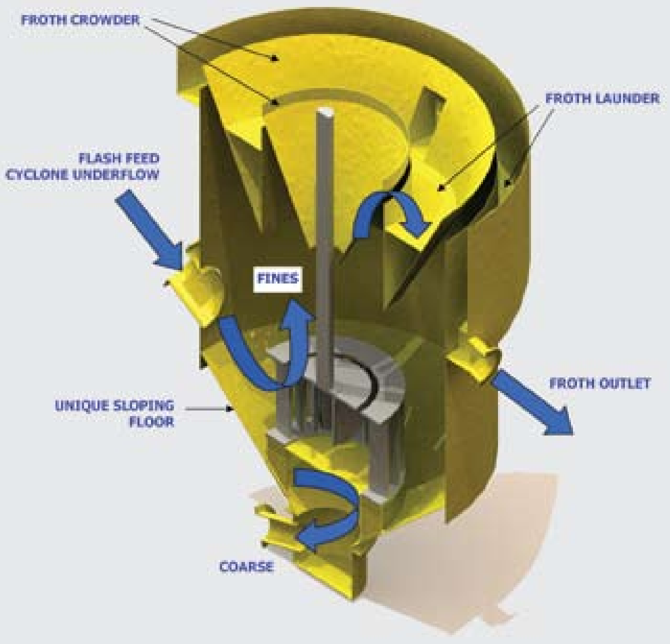


SkimAir™ in operation

Case Study: Minerals processing solutions

SkimAir™ reduces nickel overgrinding at Leinster Nickel Operation

Leinster, which began production in 1979, is located 645 kilometres north east of Perth, Australia. Leinster can produce 40 000 – 45 000 tonnes of nickel in concentrate a year. The Leinster Nickel Operation is central to BHP Billiton's Nickel West business, and has a total mineral resource of 32.6 million tonnes (underground), grading 2.3 per cent nickel and 156 million tonnes (open cut), grading 0.6 per cent.

Organisation:	BHP Billiton
Site:	Leinster Nickel Operation, Australia
Year:	2003
Application:	Flash Flotation™ of nickel using SkimAir™
Key benefits:	■ Improved overall nickel grade ■ Improved overall recovery rate by at least 1.3% and no more than 3.3% ■ Optimised, stable feed to conventional flotation circuit ■ Optimised overall flotation performance ■ Optimised grinding mill throughput ■ Optimised plant dewatering

Flash Flotation™ and Leinster

The flotation circuit at Leinster has operated with a Flash Flotation™ cell in the grinding circuit since January 1991. The decision to install the Flash Flotation™ cell (a 8m^3 SkimAir™ SK240) resulted from plant surveys showing a significant upgrading of Ni sulphides and Fe sulphides into the cyclone underflow stream returning to the secondary ball mill. Laboratory flotation tests on the secondary cyclone underflow indicated that 20%-40% of the Ni in the secondary cyclone underflow could be recovered at final concentrate grade. Following commissioning of the circuit this proved to be true.

Outotec
More out of ore

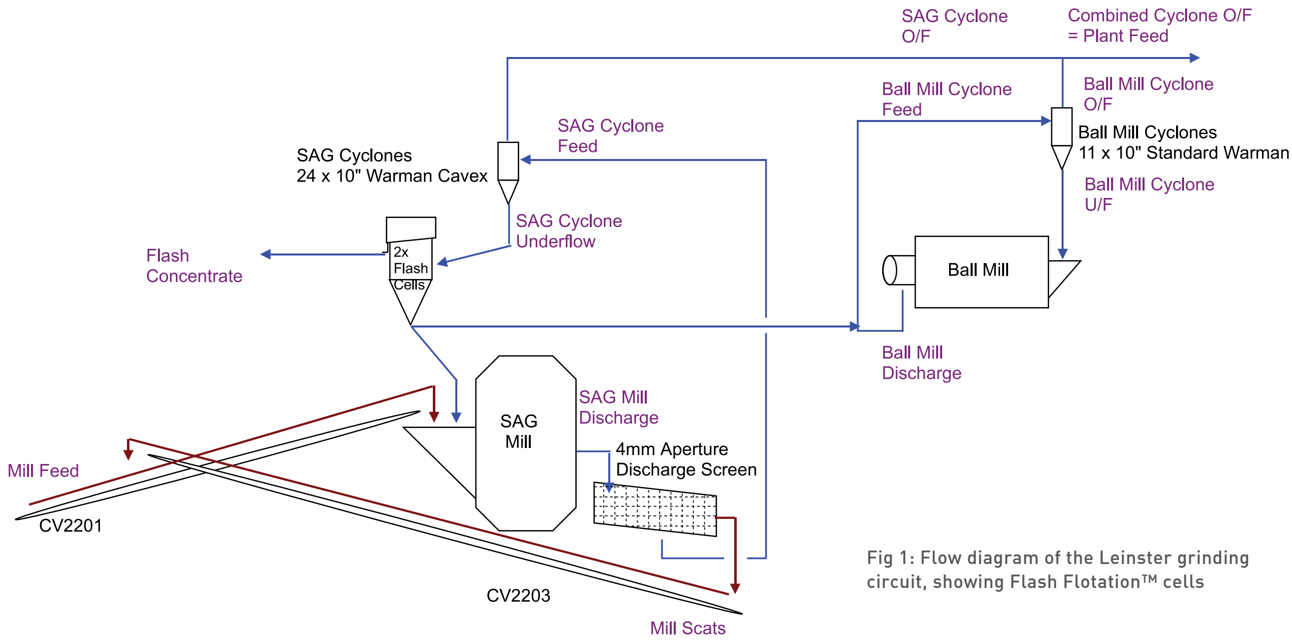


Fig 1: Flow diagram of the Leinster grinding circuit, showing Flash Flotation™ cells

Since 1991, Flash Flotation™ has been an integral part of the Leinster flotation flowsheet. During the subsequent plant expansion in 1993, a larger Flash Flotation™ cell (SkimAir™ SK500) was installed in the new AG mill grinding circuit, with another Flash Flotation™ cell (SkimAir™ SK 500) installed in 1998. A flow diagram of the current Leinster grinding circuit is shown in Figure 1.

How SkimAir™ and Flash Flotation™ work

The "flash" flotation cell was developed by Outotec in the early 1980s to "flash off" fast floating valuable minerals (hence the name) from the circulating load of grinding circuits, and therefore prevent them returning to the mill and being overground to slimes. In Flash Flotation™, the SkimAir™ unit is used as a stand-alone cell to produce a high-grade concentrate. The SkimAir™ design enables the cell to operate with the coarse size distribution and high pulp densities of grinding circuit cyclone underflows. SkimAir™ prevents particles from overgrinding, results in more stable feed to the conventional flotation circuit, improves overall recovery and the grinding mill throughput, as well as plant dewatering.

SkimAir™ testwork

As the Leinster concentrator rarely operated for any length of time without Flash Flotation™, there was little site comparison data on flotation performance with and without SkimAir™. In July 2003 during repair work, however, steel beams supporting the two SkimAir™ SK500 (23 m3) cells were found to have moved. The cells were immediately taken off line and emptied until the support structure was repaired. The following is an excerpt from the paper on some of the testwork carried out between June and August 2003 to measure the impact of SkimAir™ and Flash Flotation™ at Leinster. Greater detail can be found in the AusIMM 2005 Centenary of Flotation paper *"The role of flash flotation in reducing overgrinding of Ni at WMC's Leinster Nickel Operation"* by Julia Warder and James McQuie.

Ni Distribution (Final Concentrate + Final Tail)

	Flash Ni Recovery	Overall Ni Rec. (composite mass-balance)	Size Range		
			+75um	**-75um to + 7um**	**-7um**
June	39.4	84.6	11.7	70.9	17.4
July (Flash Cells on-line)	31.9	83.9	8.5	70.7	20.8
August	28.8	84.3	8.6	70.6	20.8
Average (Flash Flotation On-line)	**33.4**	**84.3**	**9.6**	**70.7**	**19.7**
Standard Deviation	5.4	0.4	1.8	0.2	2.0
July (no Flash Flotation)	**0.0**	**80.8**	**1.9**	**72.1**	**26.0**

Table 1.

Size Distribution of Ni in Flotation Feed

Part of the testwork involved analysing the size distribution of nickel in the flotation feed. A detailed comparison was conducted to determine the effect of Flash Flotation™ on the size distribution of Ni in flotation feed (final concentrate + final tails), and on size fraction Ni recovery. For this analysis, the composite samples representing the Leinster flotation circuit on the three days in July 2003 with the Flash Flotation™ cells off-line were compared with monthly composite data for June, July (with Flash Flotation™ on-line) and August 2003. The composite samples representing the flotation circuit with Flash Flotation™ cells off-line were sized, assayed and mass-balanced using the same procedures as the routine monthly composite samples.

The size distributions for Ni in flotation feed (defined as final concentrate + final tail), shown in Table 1, demonstrated that operating the Flash Flotation™ cells produces a coarser Ni size distribution. The proportion of Ni in the slow floating –7um size fraction increased by approximately 6% when the SkimAir™ cells were off-line.

When the Flash Flotation™ cells were operating, ~10% of Ni in the flotation feed was in the coarse +75um size fraction. Taking the Flash Flotation™ cells off-line reduced the proportion of Ni in the coarse size fraction to ~2%. Of the 8% of Ni that was removed from the coarsest size fraction, ~2% was redistributed into the intermediate fast-floating –75+7um size fraction, but ~6% was over-ground into the slow-floating –7um size fraction.

Size Fraction Ni Recovery

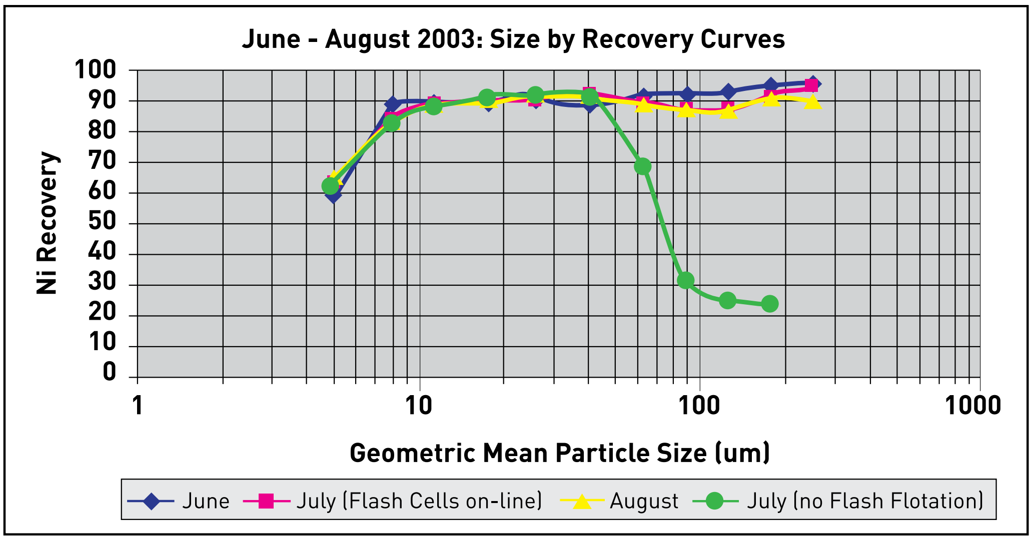
Size fraction recovery plots (Figure 2) show that fine (-7um) Ni recovery was very similar with Flash Flotation™ on and off-line. However size fraction Ni recovery fell sharply for size fractions coarser than 53um, resulting in lower size fraction Ni recovery in the coarse (+75um) and intermediate (-75+7um) size fractions when Flash Flotation™ is off-line.

Relationship between SkimAir™and overall Ni flotation

A t-test was performed to test the significance of the difference between the mean of the overall Ni recovery data with SkimAir™ on (84.1 per cent) versus the mean of the overall Ni recovery with SkimAir™ off (81.8 per cent). The t-test shows that SkimAir™ operation does result in a significantly higher overall Ni recovery.

A confidence limit of 90% was ascertained, with the 2.3% improvement in overall Ni recovery when operating SkimAir™ at (±) 1.0 per cent. Therefore, one could be 90% confident, that between June and August 2003, SkimAir™ improved overall Ni recovery by at least 1.3%, but by no more than 3.3%.

Fig. 2.



SkimAir™ and overall nickel recovery

Flash Flotation™ improves overall Ni recovery by reducing the amount of Ni overground into fine, slow floating size fractions. It also increases the size fraction recovery of Ni in the intermediate and coarse size fractions.

Conclusion

Size by size analysis of composite samples indicates that a Flash Flotation™ recovery of 33% increased the overall Ni recovery of the Leinster concentrator by 3.5%. Increased overall Ni recovery was due to improved recovery of the coarse nickel (+53µm) and the reduced production of fine Ni by over-grinding.

SkimAir™ technology also offer a multitude of additional proven benefits, including optimised, stable feed into the conventional flotation circuit, optimised overall flotation performance and optimised grinding mill throughput. Given the current demand and soaring price of nickel, the incorporation of SkimAir™ technology into the grinding circuit of a plant can result in considerable profits.

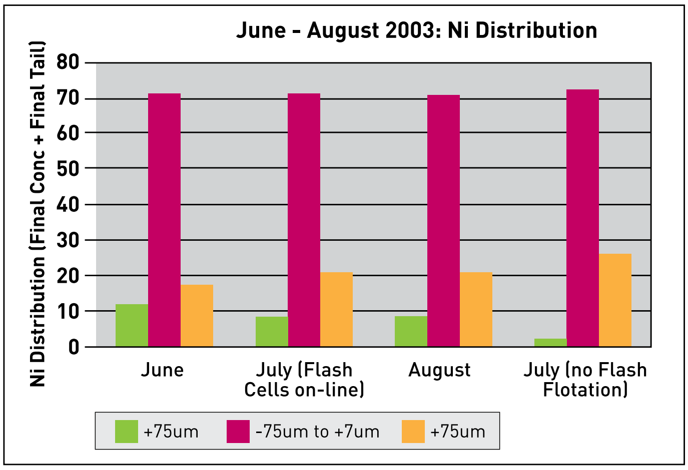


Fig. 3.

Outotec is a worldwide technology leader providing innovative and environmentally sound solutions for a wide variety of customers in minerals and metals processing as well as related process industries. Outotec Oyj is listed on the NASDAQ OMX Helsinki.

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