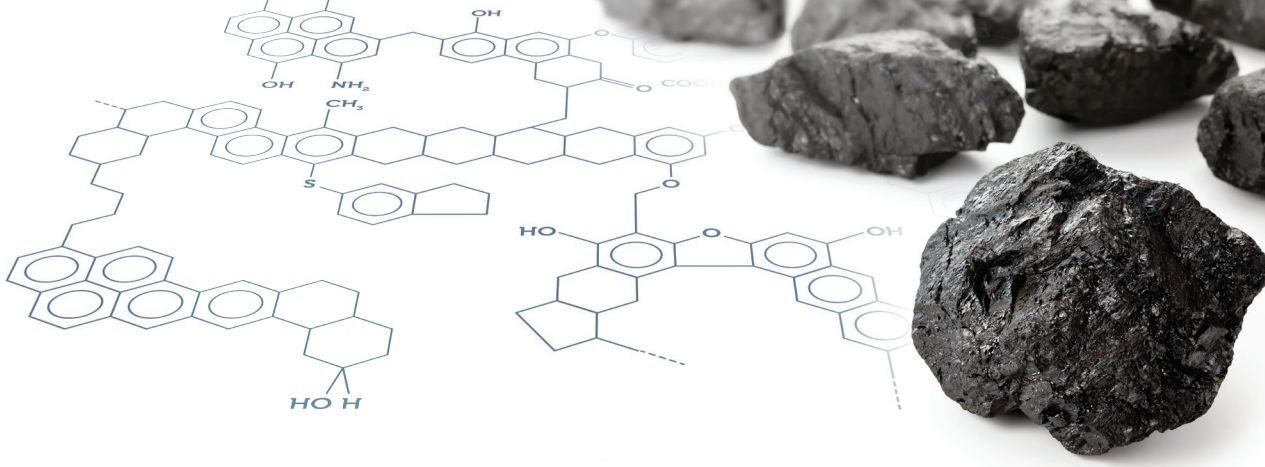

Paper 4A

Increased Fine Coal Recovery Using Baleen Filter Technology

J. Agenbag | Cape Coal Pty Ltd

Abstract

Peabody Energy Australia owns and operates North Goonyella Coal Mine near Moranbah in the Bowen Basin. The North Goonyella coal handling and preparation plant (CHPP) team identified additional recovery is achievable in their fine coal circuit. Several options, including additional flotation capacity, were considered. Based on data from the on-site Australian Coal Association Research Program (ACARP) trial of the Baleen filter technology, a project was initiated to install four (4) Baleen filters and associated services as a lower capital cost alternative to improve fine coal recovery of the coal preparation plant.

The four (4) filters accept the tailings streams from the two existing Jameson flotation cells. The filters are gravity-fed through piping that allows the screens to be bypassed when placed offline. Filter oversize (product) gravity flows to the existing flotation concentrate sumps, where it is dewatered through horizontal vacuum belt filters. Filter undersize gravity flows to the existing tailings thickener de-aeration tank.

The nature of the coal quality in the ultrafine circuit is such that the raw coarser fraction (recoverable through ultrafine screening) meets or exceeds the required product quality. Recovering this extra coal has increased the overall recovery of the CHPP without adding significant operating costs; thereby reducing the overall cost of production.

This is the first large scale installation of the Baleen filter technology within the mining industry. Baleen filters provide a surprisingly efficient means of classification by size at ultraine apertures. The installation at North Goonyella provides a basis for broader application in the coal industry.

This paper suggests an interesting explanation for the fine tail experienced in the Baleen partition curve when treating flotation tailings.

Introduction

In December 2010, Neill Turner-Dauncey (Tekpro Metallurgical), headed a project titled Baleen Filter Application (C19037), partly funded by ACARP. The project was aimed at finding potential applications in coal preparation for this new micro-screening technology, originally developed for the water treatment industry.

The concept was to capture high value coarse particles that were misplaced due to their low density by the desliming cyclones. Test work carried out on four coal processing plants showed that the valuable coarser fraction of the tailings solids could be effectively separated from the slimes, increasing the overall plant yields. One of the plants tested was Peabody Energy's North Goonyella CHPP.

This paper serves to compare the trial data with recent results obtained from the first full scale installation of Baleen filter technology at North Goonyella.

Methods

In March 2013, Peabody Energy embarked on a project to install the first large scale Baleen filters in the coal mining industry. The project consisted of four 9 m^2 Baleen filters, installed in the flotation tailings stream.

The in-house conceptual design (Peabody) was such that the entire flow would be by gravity. This negated the need for additional pumps and meant that the entire installation added the minimum additional power demand. The only electrical drives that formed part of the project were the 4 × 4 kW drives of the Baleen spray water pumps. The flotation tailings gravitate to two distribution boxes, which each feed two Baleen filters. The distribution boxes were designed with gravity overflows to the tailings thickener. This overflow arrangement, combined with actuated feed valves, meant that the Baleen filters can be bypassed fully or partially at any time, without interruption to the remainder of the CHPP.

The Baleen product gravity flows to the two existing flotation concentrate sumps, from where it is pumped to the existing horizontal belt filters. Baleen reject gravity flows to the existing tailings thickener feed box. The detailed design was performed by Ausenco Taggart on a limited capital budget and schedule.

The fabrication and installation was a team effort by the Forge Group and North Goonyella's site team. The accelerated eight week installation schedule, including critical shutdown periods, was met through focussed hands-on management by senior people in both organisations.

The installation included a new mezzanine floor directly above an operating belt filter, modiication to an existing concrete floor, and a system of gravity-low feed and discharge piping. Supporting services required an expansion of the instrument air, filtered raw water, electrical and communications systems.

Figure 1 Distribution Box and Baleen Filters 1 and 2

Safety was a key performance indicator, especially in this brownfields environment with interaction between construction, operation and maintenance crews. The project was completed without a single injury. This can be attributed to the CHPP's mature safety culture, management leadership and good, constant communication between the parties involved.

The commercial contract between Baleen and Peabody included a strict requirement to supply the units on time, as well as the requirement to meet a series of performance related expectations. The main criteria that were to be proven were:

- mechanical reliability and screen life
- volumetric drainage rate
- screening efficiency

Results

MECHANICAL RELIABILITY AND SCREEN LIFE

The filters were exposed to a 96 hour availability test, during which it had to exceed a required 90% availability. This was achieved soon after the installation was completed. The main contributor to downtime was a minor issue with the float valve control on the raw water feed to the high pressure spray water feed pumps. No mechanical issues were identiied during the performance testing period.

Spillage was a concern, with several minor spills occurring continuously from the screen underpans. This has since been addressed by the manufacturer.

At the time of publication, the screens had been operating for 16 weeks. No screening media replacement has been necessary to this point in time.

VOLUMETRIC DRAINAGE RATE

In this application, drainage rate is critical to the capacity of the units. The expected drainage rate for the 80 micron apertures was 32 $m^3/h/m^2$. This would enable the screens to handle the expected average volumetric flotation tailings rate of 1000 m^3/h. The maximum expected volumetric rate at North Goonyella is 1500 m^3/h. To handle this rate, the drainage rate would have to be increased through larger apertures, which would reduce the circuit recovery. Instead, the system was designed to be able to bypass any flow in excess of the ~1150 m^3/h screen capacity.

During commissioning and performance testing, the feed rate to the units was optimised to the extent that the screens handled the full flotation tailings stream. Basic volumetric measurements were taken with handheld low meters, which indicated the 1000 m^3/h rate was being achieved. One screen was fitted with a 63 micron screen as a trial, which proved a significant drop in drainage rate (~60% reduction in drainage).

SCREENING EFFICIENCY

The Baleen filters have proven their superior screening efficiency in other applications, so the units were expected to exhibit high classification efficiency around the aperture size. The ACARP trial at North Goonyella (CHPP #4) showed a substantial (20%) tail at the fine end of the partition curve. This was thought to be the result of volumetric bypass due to overloading.

The shape (both slope and tail) of the partition curve was very similar to that found through the ACARP trial; however, the full scale results show a coarser cut–point (d_{50}). This is partly due to the slightly coarser apertures on the full scale installation (80 micron vs 75 micron during the ACARP trial). Overall, the classification efficiency met the expectation.

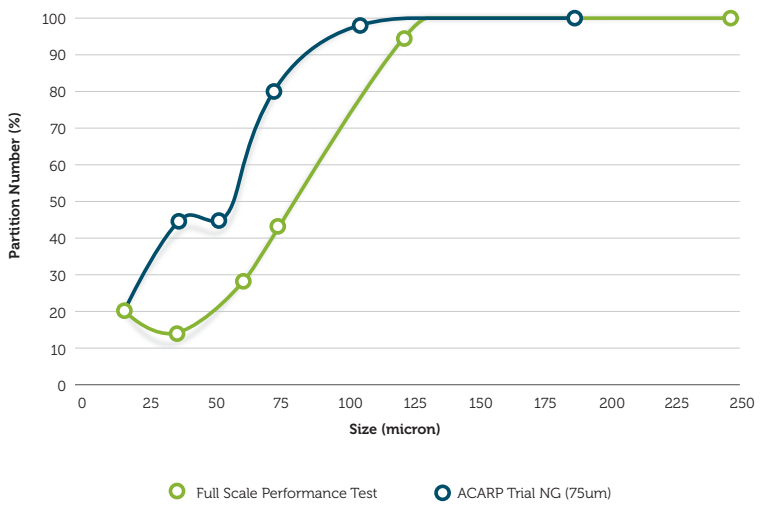

Figure 2 Full Scale Efficiency Compared to Trial (ACARP Report #19037, CHPP #4)

Table 1
Separation efficiency comparison

	ACARP Trial	Full scale Performance
d_{50} (micron)	58	82
Ep	0.025	0.023

From the first day of commissioning, the real reason behind the tail became apparent in that a pseudo flotation process was occurring on the screening surface. The high pressure spray water, combined with residual frother in the flotation tailings, meant that the Baleen filter product was extremely frothy. This was unexpected, to the extent that the product piping could not handle the volumetric flow associated with product with such a high froth factor. Permanent flush water had to be added to ensure transportation of the froth in the product piping. Trials are being conducted to alleviate froth handling concerns using non-chemical froth suppression techniques.

The performance test results confirmed that a selective process was responsible for the fine material reporting to the Baleen filter oversize (product). The -38 micron feed ash was 23.9% on an air dried basis (ad), compared to a 7.5% ash (ad) in the -38 micron in the Baleen filter product, and 27.4% ash (ad) in the Baleen filter tails. This relates to 17.6% recovery (ad) of saleable coal from the -38 micron size fraction, using Baleen filter technology.

Table 2 Baleen Filter Performance Test Results

Size Fraction mm	Baleen Feed		Baleen Product		Baleen Tails		Product Recovery (ad) %
	Fract. Mass %	Ash (ad) %	Fract. Mass %	Ash (ad) %	Fract. Mass %	Ash (ad) %	
+ 1.0 ww	0.6	11.9	1.2	8.9	0.2	22.9	78.8
-1.0 +0.500	1.3	7.8	3.1	6.8	0.2	17.8	90.6
-0.500 +0.250	7.5	4.6	19.5	4.5	0.1	19.1	99.2
-0.250 +0.150	13.7	3.9	35.8	3.8	0.1	18.1	99.6
-0.150 +0.125	2.2	4.5	5.4	3.7	0.2	17.4	94.4
-0.125 +0.075	1.2	6.0	1.3	4.3	1.1	7.3	42.2
-0.075 +0.063	2.6	5.5	1.9	3.6	3	6.2	28.2
-0.063 +0.038	6.7	8.3	2.2	12.8	9.5	7.6	12.5
-0.038	64.2	23.9	29.6	7.5	85.6	27.4	17.6
Total	**100.0**	**17.2**	**100.0**	**5.4**	**100.0**	**24.6**	**38.2**

During the early days of production, the Baleen filter product was consistently below 8.0% ash (ad), with an average of 6.5% ash (ad). The performance test resulted in a 5.4% product ash (ad), at 38% recovery (ad) of flotation tailings.

The most direct measure of the additional product recovery could be seen in the horizontal belt filter cake thickness, which increased by about 25% through the introduction of the Baleen filters. Belt speed was unchanged during the trial.

Conclusion

The early results justify Peabody's investment in the application of this new technology to the coal mining industry. Provided that these results can be maintained over the coming months and years, the project will provide a healthy return on investment.

The performance results were in line with the ACARP trial results, and show the value of such trials prior to full scale installation. The full scale installation did not result in any surprises in terms of performance, but did explain some of the findings of the ACARP testing.

Peabody's Baleen filter project is an example of how the industry can benefit from ACARP projects, provided that they are willing to take the measured risks associated with the application of new technology. Good process insight and sound commercial agreements can go a long way towards mitigating these risks.

Brownfields projects can be very successful, provided all parties buy in to the success of the project and are motivated to deliver through constant communication.

Acknowledgements

This project and paper would not have been possible without the input of the following key individuals:

(i) *Colin Nevins, Peabody CHPP Manager, North Goonyella – for his leadership throughout the project, and in particular in the area of safety //* (ii) *Paul McKenzie (and his team), Peabody Maintenance Superintendent, North Goonyella //* (iii) *Warren Ingram, Forge Group – for his hands-on management of the construction phase //*
(iv) *Hayley McIver, Process Engineer, Ausenco Taggart – for the detailed design*
(v) *Neill Turner-Dauncey, Tekpro Metallurgical – for his work during the ACARP trials, and his commitment to introduce this technology to the coal industry*

References

Turner-Dauncey, N., 2010, "Baleen Filter Application", ACARP Report 19037.

Baleen International

200 Carnegie Drive
St. Albert, Alberta
T8N 5A7, Canada
david@baleeninternational.com
+1.780.460.1036