

# The Pre-Concentration of Diamonds using the InLine Pressure Jig

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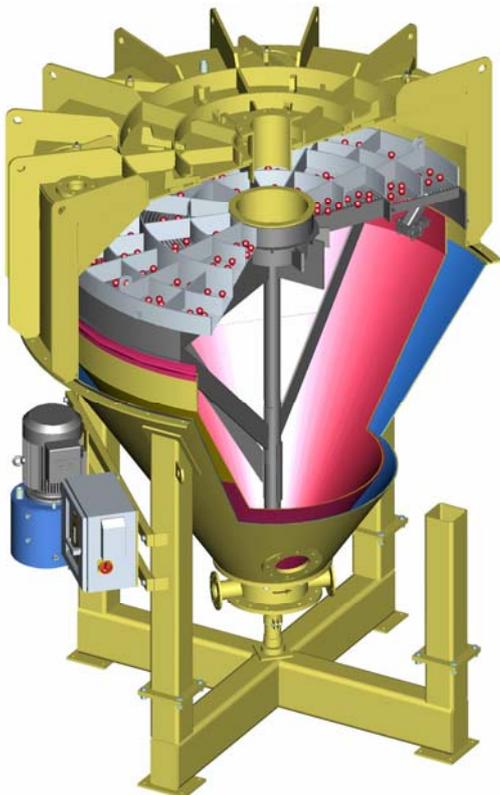
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**Abstract.** The pre-concentration of Run of Mine (ROM) ore can offer huge benefits to mining operations. The ability to upgrade the ore and maintain a high recovery can provide huge economic benefits to either greenfield projects or existing plants. To be able to perform this task at a low operating cost and for a low capital outlay can provide a new lease of life to low grade, previously uneconomic ore bodies.

Gekko Systems' InLine Pressure Jig (IPJ) has been successfully used on various types of ores in the past, however mainly for the concentration of gold and high value minerals. Gekko Systems have recently made several modifications to the IPJ to enable the unit to be used in high mass yield pre-concentration applications. Modifications, including coarse screens, larger spools and alternative control systems have been introduced in order to achieve high mass yields to sink, making the IPJ suitable for in particular diamond pre-concentration applications. The IPJ is currently utilised in over 10 different pre-concentration applications for diamonds.

Gekko Systems have been working closely with the diamond industry, especially to pre-concentrate diamond bearing ore using the InLine Pressure Jig in order to provide higher grade material to downstream processes. The benefits of pre-concentration are numerous including; lower operating costs, lower capital outlay for large tonnage operations, power savings, Ferro-silicon reagent savings, security and more importantly the environmental benefits of reducing Ferro losses to the environment.

Results to date from several installations and pilot test work trials indicate that the IPJ is ideal to pre-concentrate diamond ores including tailings, marine gravels and alluvial material to very low mass yields of between 10-30% and still maintain very high recovery of diamonds of 95-100%.



## 1. INTRODUCTION

Interest throughout the mining industry relating to the pre-concentration of ROM ore has been increasing over the years. Base metal miners in South Africa, China, Mexico and India are presently investigating the treatment of low grade ROM ores using Dense Media Separation (DMS) plants, upgrading the ore to economic grades via a pre-concentration stage. The attractions of pre-concentration to the base metal industry are obvious, with the increase in metal prices over the last few years; however, pre-concentration of other minerals such as uranium, chromite and diamonds is also common.<sup>1</sup> Pre-concentration using gravity has the potential to relieve downstream processes, especially when the liberation characteristics allow gravity to produce concentrates of economic feed grade whilst maintaining high recoveries of valuable mineral.

<sup>1</sup> Cresswell G.M., 'Pre-concentration of base metal ores by dense medium separation'. SAIMM, Copper, Cobalt, Nickel and Zinc recovery Conference, 2001

During the past few years, pre-concentration has played an increasing role within the diamond industry. Due to the high value of diamonds and the number of low grade deposits that exist around the world, pre-concentration using gravity offers a number of real benefits.

Gekko Systems were initially approached by the DeBeers research arm DebTech to investigate the separation of marine shell (gastropods) and clay from diamond bearing gravel using the InLine Pressure Jig (IPJ).

During the on site marine test work it was found that the IPJ could split the feed without losing diamonds to the tails. Utilising density tracers, recovery work indicated that 100% of the tracers could be recovered to the sinks fraction at concentrate mass yields of ~30%. After analysing the data from these early tests, the potential for the IPJ to pre-concentrate other diamond ore types was investigated. The results of this test work will be discussed in detail in the sections that follow.

## 2. DIAMOND JIGS

The InLine Pressure Jig was successfully introduced into the market in the 1990's, where it was primarily utilised in the gold industry before finding applications in several other mineral types including native copper, garnet, silver and sulphides.

Having been initially designed for gold mining where low mass yield, high grade concentrates are typically produced, the IPJ was modified to allow for its use in pre-concentration applications where higher mass yields are required. Pre-concentration of diamonds was one of the first such applications.

The introduction of a concentric circular 'wedge wire' screen enabled high mass yields to be achieved, and reduced the possibility of diamond hang up within the internal bed. Concentrate outlets, located in the specially designed spool pieces were increased in diameter and the concentrate hutch had several 'dead areas' filled to prevent the occurrence of diamond hang-up. In addition, tangential jets were introduced to assist in flushing the tailings launder, again to prevent hang up. These modifications helped to increase the achievable mass yields, but were also very important in improving the security around the IPJ.

The security aspects of the IPJ were discussed in great detail with specialists from DeBeers and additional modifications such as special tooled

nuts, lockable lids, and one-way valves on hutch water lines were introduced to further increase the security of the unit.

Stainless steel control boxes, valves and bed frames were introduced for the marine applications, necessitated by the highly corrosive environment.

The most significant development in the pre-concentration of diamonds using the IPJ was the introduction of synthetic ragging. A 3.2 S.G, polymer ragging was developed to provide a sharper cut point for separation. Previously, natural materials such as sillimanite and quartz were used as ragging; however, their unsuitable densities and shapes limited the potential of the IPJ.



**Figure 1:** A mono-layer of 3.2 S.G ragging installed at KDC's Ellendale project

Gekko Systems has now developed a range of different S.G raggings in several different sizes.

## 3. PRE-CONCENTRATION APPLICATIONS OF DIFFERENT DIAMOND ORES<sup>2</sup>

In many of the coastal marine diamond concessions including deep-water, surf-zone and beach deposits, large proportions of shell are found combined with the gravels. Shell removal is considered to be a priority due to its 'gastropod' shape and its tendency to absorb ferrosilicon, resulting in potential losses of up to 5kg/t treated. The IPJ is currently successfully employed ahead of DMS treatment in order to remove shell for preferential crushing and pre-concentrating the diamond bearing gravel.

<sup>2</sup> R. Heins, R. Spargo and A. McCallum. Successful applications of the InLine Pressure Jig with particular reference to the recovery of gold and Diamonds, SAIMM, Gravity Concentration Seminar, Jan 2003

At the NamDeb DeBeers operation in Namibia, the FTP plant discards the light shell fraction, enabling a higher throughput rate to the DMS plant. Reported diamond grades and distribution have not altered, indicating zero impact on recovery since the installation of the IPJ.

*Tailings* from conventional hard rock diamond processing plants and alluvial gravels are often found to have higher diamond content than expected. This can be attributed to several factors, such as previous process plant inefficiencies, limited use of process control, and older technologies.

The re-treatment of low grade tailings is economically justified if large volumes of tailings can be efficiently processed, resulting in a diamond-rich concentrate of low mass. This concentrate can then be economically treated by DMS or possibly by the diamond recovery plant. The Williamson Diamond Mine (WDL) use 6 IPJ 2400's to perform this task prior to a small DMS plant.

Typically, operators of *alluvial* mines work in remote regions, often situated on old riverbeds or on riverbanks. These factors dictate that equipment selection must consider both mobility and ease of operation.

Onsite pilot test work has found the IPJ to be a viable alternative to previous technology.

Due to the heavy iron stone associated with many alluvial deposits, mass yields of up to 30% are often required to ensure very high diamond recovery; however, sample preparation can reduce final mass yield from ROM feed down to as low as 7% of plant feed.<sup>3</sup>

Conventional diamond processing plants treating Kimberlite or Lamproite ores include crushers, screens and scrubbers for intensive pre-treatment ahead of the DMS circuit.

DMS plant design is often limited by volume, and the use of the IPJ ahead of DMS could result in increased DMS capacity. Existing treatment plants would therefore benefit from increased throughput with a reduction in operating costs.

The Kimberly Diamond Company have employed this to great affect in their West Plant at the Ellendale mine. Feed to the West Plant consists of 100 tph of scrubbed ROM ore, which is fed to a single IPJ 2400. Concentrate is screened at 2mm to produce ~7 tph of product, which is treated in a small DMS plant. KDC also realise a significant operating cost savings by pre-concentration.

#### 4. BENEFITS OF PRE-CONCENTRATION

The potential benefits of the IPJ to pre-concentrate low grade deposits and provide upgraded feed to downstream processes are enormous. The IPJ has the potential to pre-concentrate ores at a fraction of both the operating and capital cost of other technologies such as DMS.

The IPJ is typically employed ahead of a small DMS plant; however, investigations into secondary jigging are planned in the near future. Other secondary recovery methods such as x-ray and optical sorting are also possibilities. Some low tonnage alluvial operators have employed grease tables to great effect for treating IPJ concentrates.

A typical flow sheet is outlined below.

TYPICAL FLOW SHEET

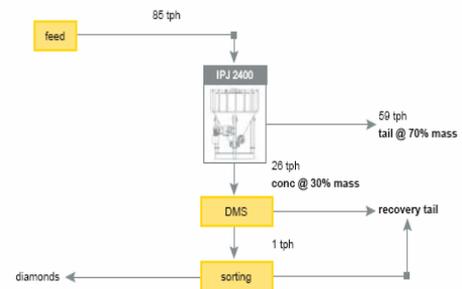


Figure 2: Example of a Typical IPJ Diamond Flowsheet

Due to its compact design and minimal peripheral equipment requirements, the IPJ is extremely mobile. This *mobility* and compact footprint means that the IPJ is easily retrofitted into existing plants, enabling a quick and economical upgrade. This mobility also enables the IPJ to be moved to coincide with different mining areas or simply relocated to other deposits.

<sup>3</sup> Rajesh Shah, Project Metallurgist, Argyle Diamond Mines, Recovery of Diamonds from Alluvial Deposits, Jig Interim Report – Metallurgical Projects & Technical Support. May 2005.

In arid areas the availability of water can severely limit the use of traditional gravity treatment options. The IPJ requires a slurry feed and extra water for the hutch; however, the quality of the water required is low. The IPJ can handle up to 2% solids in the water before affecting performance. This low water quality requirement means that its applicability in water sensitive areas is improved. In addition, the fact that no reagents or other media are added to the process means that excess water can be returned to natural watercourses with *zero environmental* impact. Water can also be recycled back using cyclones or thickeners for the IPJ hutch or to feed slurry requirements.

As a continuous concentrate discharge unit, the IPJ offers a high degree of flexibility. Mass pull to concentrate can be varied from 0.5% up to 30% to optimize recovery for a particular application. This *versatility* enables pre-selected operating conditions to be programmed into DCS control systems, and altered as an ores' characteristics change. This is particularly relevant when moving from high shell areas to high gravel areas in marine applications.

The IPJ can accept a *wide feed size* range of 0 to 25mm. In many circumstances, this may eliminate the requirement for an additional screening step. Although this is possible, it is still recommended that the material be screened into different screen fractions if concentrate yield is to be optimized.

The capital and operating cost savings *when using pre-concentration can be significant*. An example of the savings that can be realised is outlined below.

The power consumption of a DMS plant is typically very high. In some countries, power costs are close to \$0.25 Kwhr. The power requirement of a typical 600 tph DMS plant would be in the vicinity of 2 MW; however, the use of the IPJ as a pre-concentrator could reduce the ROM feed rate by 70% from 600 to 180 tph. Assuming the power requirement of the DMS plant drops by 70% to 600 Kw, and the 600tph jig plant requires 24 Kw then the total power requirement is now only 624Kw. This is a considerable **operating cost saving** for the life of the project.

Not only is there considerable operating cost savings, but the capital cost for a 600 tph DMS plant would be close to AUD \$17M. By comparison, the cost of a 200 tph plant is approximately AUD \$10M. The capital cost of 6 x IPJ2400's is AUD\$1M. This represents a total plant cost of only AUD\$11M, a saving of AUD\$6M or 35%.

The above-mentioned example is subject to various assumptions and the prices may vary from project to project. However, the cost savings can be quite considerable and very attractive for not only low grade deposits, but also greenfield projects in remote areas where 'capital' is at higher risk.

The pre-concentration of diamond ores is proven to be economically viable; however, the benefits are only realised if the low mass yields produced by the concentrator also result in very high recovery. Due to the high value of diamonds, a small decrease in recovery can affect NPV's and IRR's considerably.

The IPJ test work to date has been very successful and further advances in ragging technology have enhanced recoveries in the smaller size fractions. Many of the installations have reported excellent diamond recoveries down to -2mm.

## 5. TEST WORK HISTORY

### 5.1 DeBeers Marine

The potential of the IPJ as a suitable diamond pre-concentrator for marine gravels was initially investigated by DeBeers technical arm DebTech in 1998. A DebTech technician performed pilot scale test work using an IPJ600 at Gekko Systems facilities in Australia.

For the test work, slurry consisting of real marine gravels, gastropod shell and clay particles was used to determine achievable cut points. Tracers were added to the IPJ feed, and the resulting float and sinks streams were hand sorted to determine unit efficiencies. Figure 3 highlights the results of the early test program.

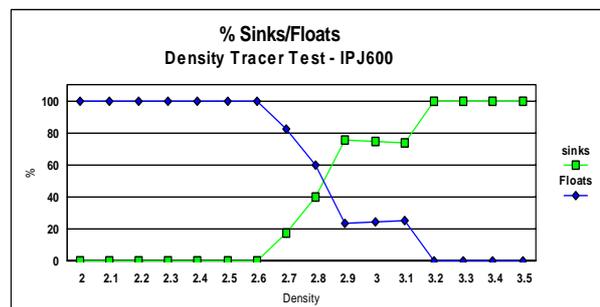


Figure 3: 4 mm Partition Curves Produced During early IPJ Test Work

At the completion of the Australian trials, a larger 40tph IPJ1500 was purchased and sent to Cape Town, South Africa. Further pilot scale tests were performed in-house by DeBeers. The initial tests indicated that the IPJ was highly successful in separating shell material from the gravel in the marine applications. Subsequently, IPJ's were installed on several diamond marine vessels.

## 5.2 Kimberley Diamond Mine (KDC)

Kimberley Diamond Companies' Ellendale IPJ was initially specified to reject 'spear grass' and other organic material from the scrubbed ROM feed. This material was found to have a negative impact on the performance of the downstream DMS circuit. After on-site test work using the IPJ1500 (40tph), results indicated that the IPJ could successfully reject 100% of the spear grass but also pre-concentrate 30% of the gravel into a high grade stream.



**Figure 4:** The IPJ1500 test unit at KDC's, Ellendale Mine.

The test involved ROM sample being fed via a grizzly to a feed conveyor and into a trommel/scrubber. The feed was scrubbed at approximately 50% solids, and the trommel discharge was sized at +0 -15mm. Feed was pumped using a Warman 3/2 pump, via a three-inch line to the IPJ1500. The tails was transported over a 1.25mm screen with the underflow pumped directly to a tails dam and the oversize removed via conveyor to a coarse tailings heap. The concentrate was dewatered and collected in 200 litre drums. The jig operated with a 20 mm wedge wire screen and was filled with, -30 + 20 mm quartz ragging (S.G 2.6).

For the test work, feed rate to the unit was set to 20 tph, with approximately 30% of feed material reporting to the sinks fraction. 'Spear grass' was introduced onto the feed conveyor for an approximate 30 minute time period. The initial results from the tests were extremely positive, the concentrate produced from the IPJ contained no organic matter.

To audit IPJ recovery efficiency, 40 (20 x +2-4mm and 20 x +4-8mm) 3.5 S.G. diamond tracers were introduced to the feed via the trommel discharge sump. Twenty of the +4-8mm beads were recovered and 19 of the +2-4mm beads were recovered, resulting in a recovery of 98% of all diamonds into a 30% mass yield.

As a result of the test work, an IPJ2400 was sourced from Gekko Systems and continues to operate in the west plant. Communications with mine site personnel indicate mechanical availabilities for the IPJ average in excess of 95%.

While the benefits of increasing the availability of the DMS due to the rejection of the spear grass were evident, the real economic effects of pre-concentration for KDC were profound. The 7tph DMS module was able to treat the sized material produced from 100tph of ROM ore after the introduction of the IPJ2400.



**Figure 5:** The IPJ2400 in the West plant, Ellendale Kimberley Diamond Co. (2004)

Recent results from KDM's quarterly report indicate that the IPJ west plant is operating at a lower cost as compared to the DMS only East plant by AUD1.00/tonne. This resulted in a bottom line savings of 14%.<sup>4</sup>

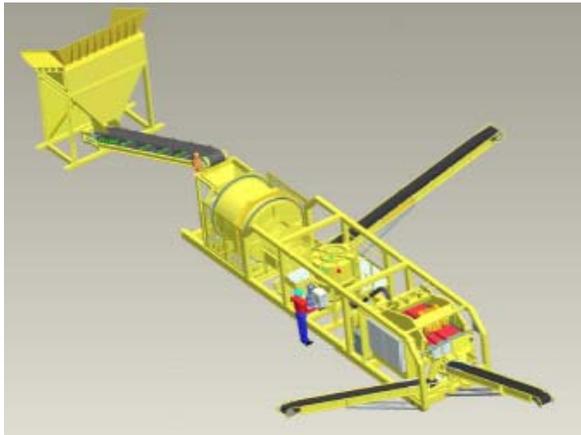
## 5.3 Argyle (Rio Tinto)

Argyle Diamond Mine has recently investigated the pre-concentration of alluvial diamonds from outlying deposits. The alluvial deposits have increasingly moved further away from the processing plants. Transport cost has made these deposits uneconomical and pre-concentration on site was investigated as a means to reduce both the transport and processing costs.

Gekko Systems designed and supplied a 20 tph diamond pilot plant and transported it to Argyle for on site tests.

<sup>4</sup> Kimberley Diamond Company NL Quarterly Report For The Period Ended June 2004

The pilot plant consisted of a feed bin, 20 tph scrubber, feed preparation screen, InLine Pressure Jig (IPJ1000) and floats and sinks dewatering screens. A Gekko Magnetic Tracer Recovery System located at end of sinks and floats screens was also incorporated into the design to allow for auditing of the circuit during 'feed-on' conditions. This was a vast improvement on previous hand sorting methods employed in the past. Illustrations of the pilot plant and magnet recovery system are illustrated in Figures 6 and 7 below:



**Figure 6:** Gekko Systems 20tph Diamond Recovery Pilot Plant, used by Argyle.



**Figure 7:** Gekko Magnet Tracer Recovery System for Argyle Pilot Plant

The test work scope included jiggling bulk samples of alluvial material with the final concentrate and tailings to be treated through a 'Mark III' DMS plant for complete auditing of both streams. Prior to processing of the bulk samples, the circuit was optimized using magnetic density tracers.

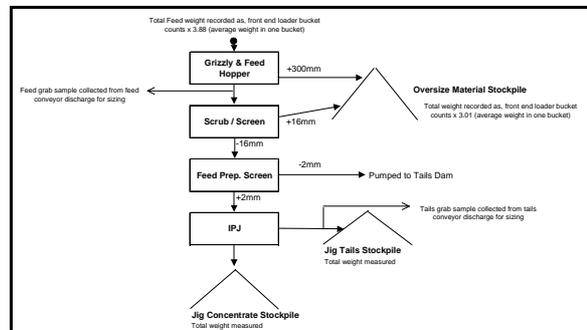
As part of the optimization effort, several tracer tests were conducted at various jig parameter settings. In one such test, 1380, 3mm, 3.5 S.G tracers were added to the jig feed, with 1335

reporting to concentrate for a recovery of 96.7%. Mass yield was approximately 30% at a corresponding feed rate of 4 tph.

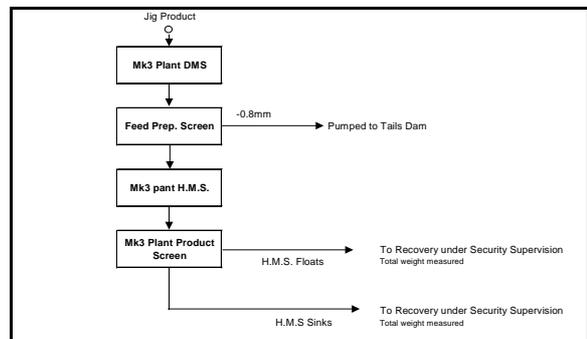
Due to the size distribution of the alluvial material, only 4 tph of +2.0 -16.0mm material was produced from 20tph of ROM feed. This meant that the IPJ1000 was underfed by about 75% for a portion of the test program.

Optimum ragging depth for the application was determined to be a single layer of ~95% coverage. This enabled the ragging to move around on the screen and provide large interstitial gaps within the bed, and helped to prevent the screen from pegging.

Figures 8 and 9 summarize process flows for the continuous test program.



**Figure 8:** Flow sheet for Stage 1 Alluvial Processing at Argyle:



**Figure 9:** Flow sheet for Stage 2 Processing

For the first continuous test, a total of 715t of feed was processed through the jig plant at an average scrubber feed rate of 21.7t/h. The total jig concentrate collected was 29.9t (28.8% of jig feed, 4.2% of the scrubber feed). Average operating conditions for the trial are listed in Table 1.

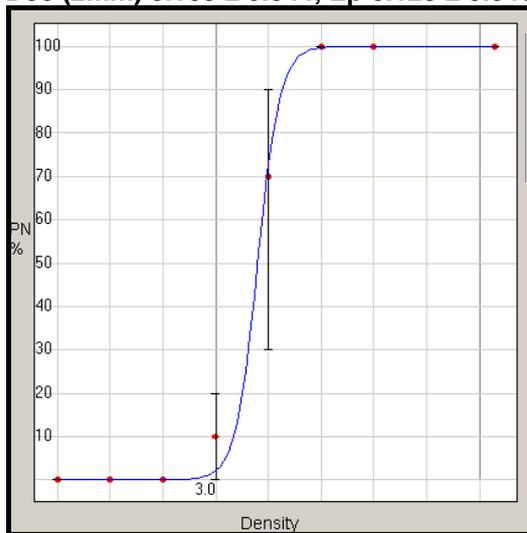
**Table 1: Average Jig Operating Conditions for Alluvial sample No.1**

Operating Time (h)	Jig Feed Rate (t/h)	Jig Feed % Solids	Conc. Flow Rate (t/h)	Tails Flow Rate (t/h)	Conc. Mass Yield (%)
33	3.16	6.64	0.91	2.25	28.8
Scrubber Jet Pump Water (m3/h)	Feed Pump Water (m3/h)	Feed Volume (m3/h)	Hutch Water (m3/h)	Tails Volume (m3/h)	Conc. Volume (m3/h)
39.1	43.1	45.5	35.7	62.41	20.1

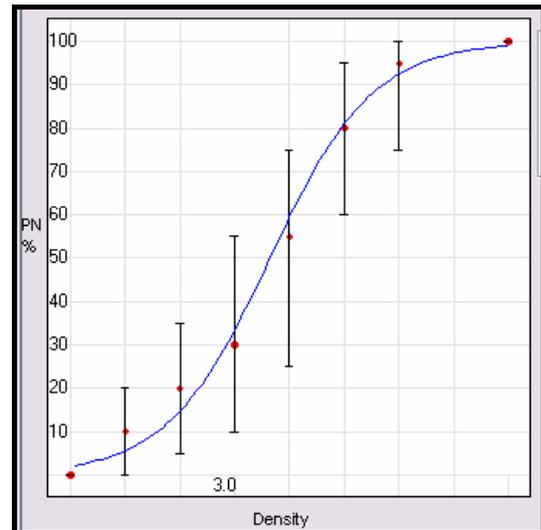
Other fixed operating conditions during the trial were: 110 - cycle rate, 8.0 - stroke length, 10.0 - down stroke and IPJ internal pressure of 50kPa.

During the continuous operation of the plant, tracers were added to the feed as a means to determine operating efficiency. Results from the audits were plotted in graphic software, and are highlighted in Figures 10 and 11. The jig density split for the various size beads were also determined:

**D50 (6mm) 3.080 ± 0.037, Ep 0.023 ± 0.028**  
**D50 (4mm) 3.080 ± 0.037, Ep 0.023 ± 0.028**  
**D50 (2mm) 3.109 ± 0.044, Ep 0.129 ± 0.046**



**Figure 10:** Partition curves produced from tracer data for 4mm tracers



**Figure 11:** Partition curves produced from tracer data for 2mm tracers on alluvial samples at Argyle.

After treating the alluvial material through the jig plant, both the concentrate and tailings streams were separately processed through a MKIII DMS plant, to audit the IPJ's performance. Results from the audit are outlined in Table 2:

**Table 2: Diamond Recovery Results for First Continuous Alluvial Sample**

Jig Concentrate		Jig Tails		Jig Feed	
Stone Count	Carats	Stone Count	Carats	Stone Count	Carats
2361	99.86%	9	0.14%	2370	100%

The second stage of the test program focused on testing the IPJ closer to its designed capacity. In an attempt to investigate the unit at higher throughputs, the prepped jig tails and concentrate were combined and were re-processed through the IPJ at ~7.0tph.

**Table 3: Average Jig Operating Conditions for 7tph test Sample No. 2**

Operating Time (h)	Jig Feed Rate (t/h)	Jig Feed % Solids	Conc. Flow Rate (t/h)	Tails Flow Rate (t/h)	Conc. Mass Yield (%)
15	7.01	10.6	2.4	4.62	34.1
Scrubber Jet Pump Water (m3/h)	Feed Pump Water (m3/h)	Feed Volume (m3/h)	Hutch Water (m3/h)	Tails Volume (m3/h)	Conc. Volume (m3/h)
32	54.6	62.1	36.1	104.4	22.4

Other fixed operating conditions during the trial were: 110 - cycle rate, 10.0 - stroke length, 10.0 - down stroke and IPJ internal pressure of 50kPa.

For the second portion of the test work, a total of 107.0t was processed. The total concentrate

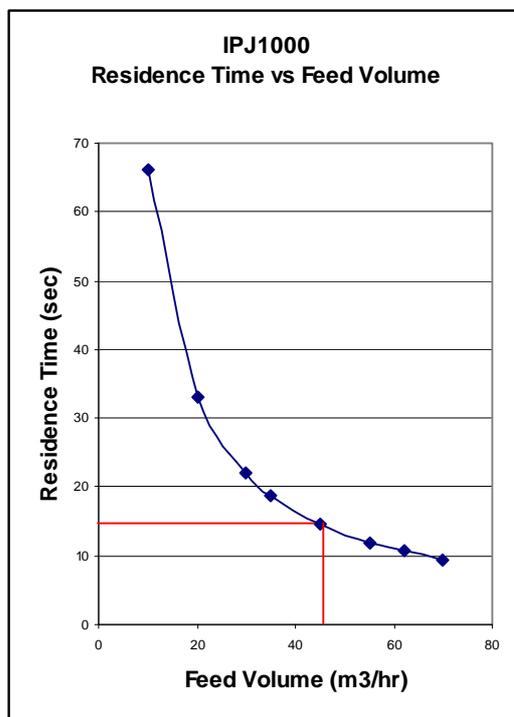
collected was 17.3t, with an average recovery of 85% using 3mm beads of SG 3.53.

The jig density split for the various size beads was also determined:

**D50 (6mm) 3.010 ± 0.109, Ep 0.176 ± 0.130**  
**D50 (4mm) 3.057 ± 0.112, Ep 0.156 ± 0.078**

Overall diamond recovery for the second test was much lower at 78.3%; however, after further investigation it was noticed that the feed volume to the IPJ1000 had increased from 45m<sup>3</sup>/hr (name plate capacity) up to 65m<sup>3</sup>/hr. This increase in volume was found to be due to wear in the jet pump nozzles. This resulted in a decreased residence time within the IPJ, and the increased velocity of material across the bed.

When comparing the two tests, the IPJ recovery dropped dramatically after the volumetric feed rate increased above the specified volume of the unit. The feed densities used for the tests were much lower than the recommended feed density of 35 - 45% w/w. Increasing the volume treated reduces the residence time and lowers the recovery. This effect is illustrated in Figure 12, which highlights the minimum residence required to achieve 100% recovery of 3.5 S.G tracers.



**Figure 12:** Minimum Feed Volume and Residence Time Required for 100% xx mm, 3.5 S.G. Tracer Recovery

#### 5.4 Williamson Diamond Mine (WDL)

Williamson Diamond Mine processes ore from one of the largest kimberlite pipes in the world.

The mine has been in operation since 1940<sup>5</sup> and is currently a joint venture project with DeBeers and the Tanzanian government. The feed grade of the pipe is low (~6cpt), which prompted management to look at pre-concentration options for the vast tailing deposits located on site to augment production. The promising results achieved by the IPJ in the marine test work led to the unit being investigated for tailings re-treatment.

The test work proved that the IPJ could pre-concentrate diamonds from old tailings deposits and produce an upgraded diamond feed to a small DMS unit.

Test work performed by WDL indicated that high recoveries were achievable from the 'light' tailings into a low concentrate mass yield. Results from this test work are outlined in tables 4:

**Table 4:** IPJ test work results

Test number	1	2	3	4	5	6
Screen (mm)	13	13	7	7	27	27
Ragging (mm)	15	15	10	10	30	30
S.G of Feed	1.35	1.35	1.35	1.35	1.35	1.35
Feed rate (tph)	38.3	30.4	27.0	28.9	24.3	24.9
Yield (%)	5.0	4.8	3.0	2.9	15.0	

% Recovery	Test number					
	1	2	3	4	5	6
4 mm	93	85	78	73	98	95
6 mm	100	100	95	91	100	97
8 mm	100	100	100	98	100	100
12 mm	100	100	100	100	99	100
16 mm	100	100			100	100
20 mm	100	100			100	100

Based on the results, six IPJ2400's were procured and installed as part of a 600tph tailings re-treatment plant. Several difficulties were encountered with the project, mainly due to process control issues, which led to the temporary de-commissioning of the jigs.

In 2005, Williamson management instigated a refurbishment program to the jig plant. As part of the refurbishment program, automated belt feeders, weightometers and variable speed drives on the feed pump were added to one jig within the circuit. Instrumentation to the feed, tailing, and concentrate lines was also added. This proved to dramatically increase the availability and performance of the IPJ.

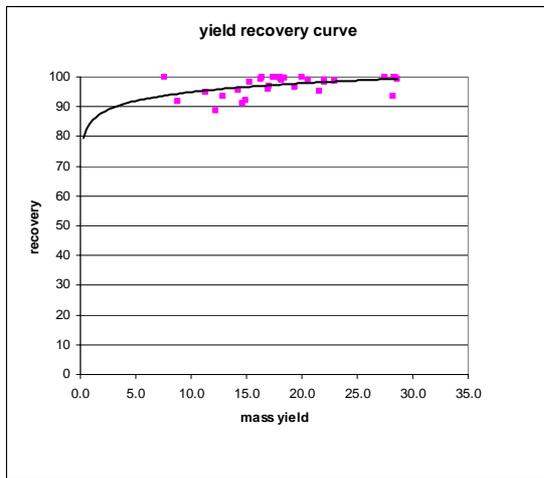
A new test program was performed in June 2005, which confirmed the recoveries from the early test work. Mechanical parameters are summarized in Table 5 below.

<sup>5</sup> [www.mwadui.co.uk](http://www.mwadui.co.uk)

**Table 5: Mechanical Parameters for the June 2005 Test Program**

Internal Screen Aperture Size	28 mm
Ragging Type	Polyurethane
Ragging Shape	Spherical
Ragging Diameter	32 mm
Ragging Density	3.2 S.G

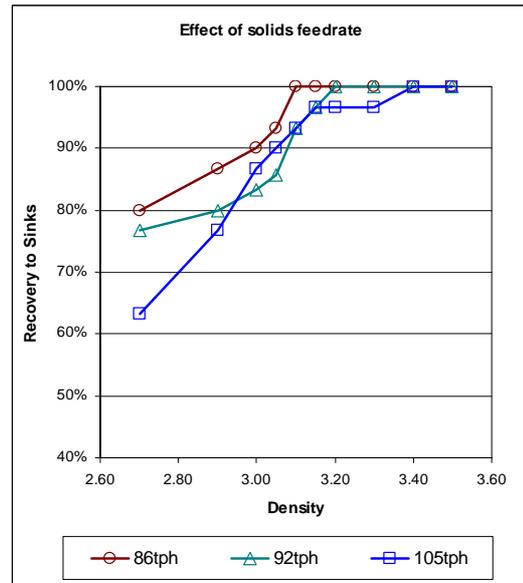
A series of 40 batch tracer tests were performed in order to optimise the unit.



**Figure 13:** The yield /recovery curve for optimised tests performed.

The tests investigated the effect of various operating parameters on mass yield and recovery, which enabled the units to be optimised for continuous operation. Figure 13 summarizes these results. At the end of the optimization process, tracer recoveries of 100% (+ 4 mm, 3.5 S.G.) into a mass yield of 10% to 15% were consistently achieved.

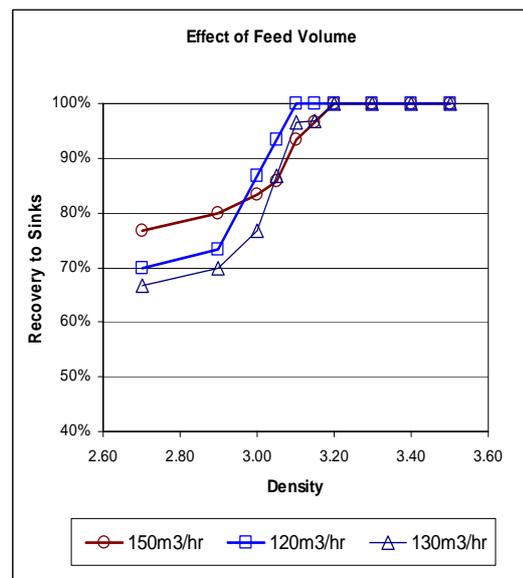
The IPJ2400 is normally rated at 100tph of solids (100tph @ 50% w/w @ 2.6S.G); however, due to the low S.G of diamond tailings the IPJ tonnage was conceptually de-rated to ~80tph. A series of tests were performed to determine the *effect of feed rate* to the IPJ2400. The results are outlined below.



**Figure 14:** 8 mm Partition Curves at Various IPJ Solids Feed Rates

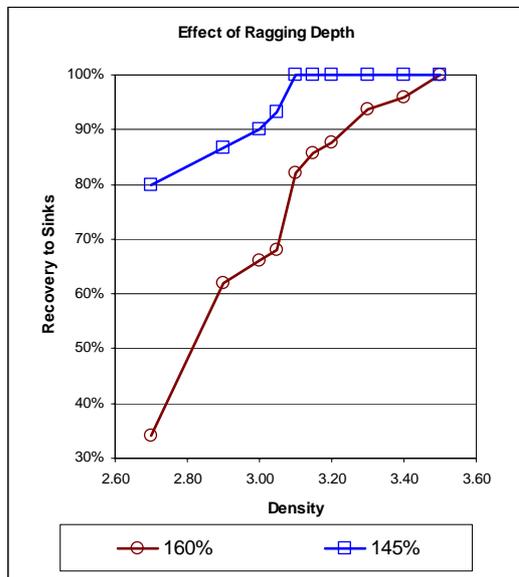
Increasing the feed rate to the IPJ was found to increase its cut point (Figure 14). Each test was run at 100 cpm, 32 mm stroke length, 150m<sup>3</sup>/hr and 146% ragging coverage.

The effect of volumetric flow rate was also investigated, and as expected, lower feed volumes resulted in reduced cut-points and higher recoveries. This is primarily due to the higher residence time within the IPJ. The tests were all conducted at identical feed rates, and it appears that a higher feed density had no adverse affect on recovery.



**Figure 15:** 8 mm Partition Curves at Various Volumetric Flow Rates

Ragging depth was also identified as a critical parameter. When the ragging layer was too deep, mass yields to sink were not controllable using the range of parameters available to the IPJ. When ragging depths were reduced and the interstitial spaces optimised, the IPJ parameters enabled mass yields to be controlled and cut points to be altered.



**Figure 16:** 8 mm Partition Curves at Ragging Depths of 145% and 160%

Continuous tests were also performed with mass yields of 10-15% recovered to sink. During the continuous tests, tracers were periodically added to the feed to monitor IPJ performance. It was reported that 100% of the 3.2 through 3.5 S.G. tracers were recovered to sinks.

A parcel of previously recovered 'boart' diamonds was marked and also added to the feed. This was recovered by the DMS plant and recovered in the sort house. The result of this test was to audit the above test and results are still pending.

The real benefit to WDM is that the tailings dump grade will be upgraded by 8-10 times, enabling economic grades to be fed to the downstream DMS circuit, which will increase overall carat production.

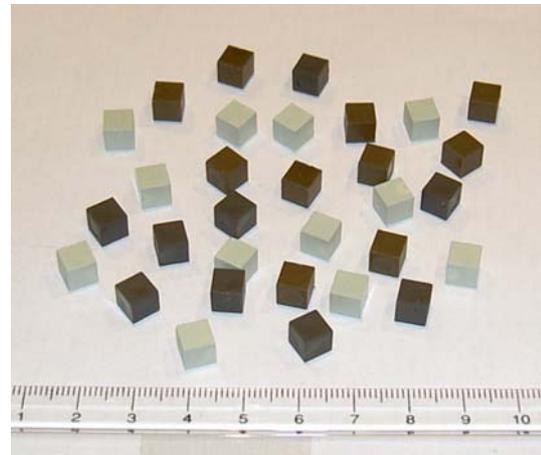
### 5.5 Ekati (BHP)

An IPJ1500 has been sent to BHP's Ekati mine in the Northwest Territories Canada to investigate the pre-concentration and recovery of -2.00mm diamonds. Test work is expected to commence before the end of the year.

### 5.6 Diamond Tracers

Gekko have developed a range of magnetic composite tracers that can be used in diamond recovery trials. Gekko Systems initially developed

this product as IPJ ragging; however, found that the material can be produced into any shape and density required. The density tolerance is +/- 0.01g/ml and 3mm tracers at an S.G of 3.5 have been developed and trialed.



**Figure 17:** Illustration of 8 mm Gekko Magnetic Tracers

The tracers can be made to various shapes and S.G., which makes them ideal for use in multiple applications. Due to their affordability, high volumes can be used without fear of loss to tailings.

## 6. CONCLUSION

The results obtained from the diamond test work are proving the IPJ's value as an ideal apparatus for diamond pre-concentration. Gekko Systems believe that the IPJ offers many potential benefits for the diamond industry in marine, alluvial and tailings re-treatment applications. The low mass yields and high recoveries achievable offer the industry a low capital, low operating cost option for treating low grade deposits.

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