High Tonnage Separation by Enhanced Gravity - The Kelsey Centrifugal Jig

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Abstract

The Kelsey Centrifugal Jig utilises all the parameters of a conventional jig as well as the additional feature of being able to vary the apparent gravitational field acting on very fine particles and across the ragging bed.

Until recent developments the Kelsey Centrifugal Jig was limited due to its size in treating only about 35mtph of solids. In many applications this tonnage was even lower at less than 15mtph.

Even with this tonnage restriction the Kelsey Centrifugal Jig has completely dominated in a short period of time the separation of zircon from high aluminium containing sands around the world.

The commercial release of the new series of Kelsey Centrifugal Jigs which includes the Kelsey Model J1800 results in the tonnage limit per machine well exceeding 100tph depending on the application.

Introduction

Mineral jigs for many centuries have been used by the mining industry to extract coarse liberated particles from a wide range of minerals. Chris Kelsey has revolutionized the mineral jig industry by designing and manufacturing the only enhanced gravity jig on the world market to date.

The advancement of the Kelsey Centrifugal Jigs since its conception has been almost as swift and ingenious as the idea itself. Mechanical availability exceeds 95% world wide with particular plants recording 98% availability.

The recent commercial release of a new series of jigs which includes the Kelsey Model J1800 has been proven with the assistance of several concentrators around the world to be a substantial improvement in terms of tonnage with minimal effect on metallurgical performance.

The Kelsey Centrifugal Jig

The concept of the Kelsey Centrifugal Jig utilises all the parameters of a conventional jig as well as the additional feature of being able to vary the apparent gravitational field acting on very fine particles and across the ragging bed.

Whereas, in a conventional jig, the dynamics involve only specific induced movements, the Centrifugal Jig takes a conventional jig and spins it in a centrifuge. The ability to change the apparent gravitational field, up to 50 times gravity, results in a major improvement in separation efficiency, particularly of very fine minerals, by significantly reducing the effect of forces that hinder fine particle separation.

Generation of the centrifugal force is achieved by variable speed control of a spinning rotor. Inside the rotor, a screen of parabolic shape is spun coaxially together with the rotor. The screen is lined inside with ragging material which is evenly spread by the centrifugal force.

The feed pulp passes down the fixed central pipe and is distributed over the base of the ragging. The particles in the feed are accelerated towards the ragging bed, due to the apparent gravitational force, while continually rising up the bed, due to the vertical displacement caused by the incoming feed.

Those particles whose specific gravity exceeds or equals that of the ragging material will be allowed to settle in the ragging bed. Having penetrated the ragging bed, the particles then go through the processes of hindered settling and consolidated trickling. The heavier minerals pass completely through the ragging retention screen and into the concentrate hutches where they ultimately pass as slurry through concentrate spigots and into the concentrate launder. Lighter minerals that are not able to settle will be discharged over the top of the screens ragging retention ring and into the tailing launder.

The process of hindered settling within the bed is not only accentuated by the centrifugal force, but also by the pulsing of the ragging bed. The pulsing of the bed is achieved via pulse arms connected to pads to work against the jigs flexible diaphragm. Water contained within the concentrate hutches presses against the diaphragm, at a frequency and amplitude set by the operator, thus dilating the ragging bed. The level of dilation impacts on the amount of material able to pass to concentrate.

The shock wave produced by the pulses have a twofold effect. Firstly they dilate the ragging bed, as mentioned above, allowing minerals to enter the bed. Secondly they accentuate the different rates of acceleration between particles of differing specific gravities. This phenomenon can be explained in the following way:

Particles that are subject to a constant force will accelerate at a rate proportional to their mass until they reach a terminal velocity. This terminal velocity is mainly linked to the surface area of the particle. Therefore particles of the same size but differing specific gravities will separate when placed in a field of constant force but will slow their separation rate once they reach their terminal velocity. The shockwaves, produced by the pulsing action of the jig, continually stop the particles, thus limiting their time at their terminal velocity and maintaining a high rate of separation.

Metallurgical Performance of the J1800

Many papers have been written over the years by plants operating or evaluating the Kelsey Centrifugal Jig and the metallurgical results have always been very impressive. The commercial release of the new series of Kelsey Jigs has now made the device much more amenable to processing high tonnage streams economically.

A recent trial was conducted at a gold operation, in which the aim was to recover at high tonnage the gold bearing sulphides in the processing plant tailings stream. Numerous feed rates were tested to identify where the optimum throughput was for the application.

Table 1 - Tonnage Comparison of Model J1800

Feed	Kelsey Jig Concentrate		
mTPH	Wt %	S %	Rec. %
42	22.0	5.09	61.8
50	4.14	9.2	56.9
65	5.35	8.4	51.7
83	8.32	7.9	47.2
100	8.54	10.4	54.8

The Kelsey Centrifugal Jig for many years has been considered by most to be the ideal gravity separating device for low grade iron streams due to its ability to generate high enrichment ratios whilst maintaining high recoveries.

Until the development of the Model J1800 the equipment did not manage on most iron applications to be economic. The tonnage ability of this new model now makes most low grade iron applications not only economic but lucrative.

In a iron processing plant the Kelsey Jig Model J1800 achieved very good recoveries on a final gravity tails stream whilst producing a final grade concentrate in single pass. The treatment tonnage was 55mtph with an average of 5.5mtph of final grade concentrate being produced.

Table 2 - Size Distribution from a Kelsey Jig Operating in Iron Ore

Size	***Feed***		***Concentrate***		***Tail***		***Rec.***	***Reject.***
µm	Wt%	Fe%	Fe%	Si%	Fe%	Si%	Fe%	%Si
300	4.63	13.2			13.2	76.83		
212	19.71	8.39			8.4	86.89		
150	24.93	6.06	42.7	32.86	5.9	92.34	3.06	99.85
106	21.78	5.92	57.9	15.1	5.1	92.69	15.17	99.74
75	11.76	11.11	65.1	5.81	5.8	90.82	52.46	99.38
53	5.63	21.03	67.2	2.51	7.7	84.95	71.58	99.15
45	4.55	45.15	68	1.78	10.6	71.6	90.65	96.38
-45	7.00	44.33	66	3.8	21.8	57.64	75.90	93.58
Total	**100**	**12.71**	**65.87**	**4.00**	**7.39**	**88.19**	**47.14**	**99.5**

It can be seen clearly from table 2 the ability for the Kelsey Centrifugal Jig to produce final grade iron ore from a very low and partially liberated stream. This is particularly evident in the finer size fractions.

Mechanical Operation of the Kelsey Centrifugal Jig

Since the completion of Mechanical R&D from 1988-92 the purchasers of Kelsey Jigs have been enjoying excellent mechanical results at their installations. The Jigs are being installed with control equipment and automatic screen cleaners which makes them an operator free piece of equipment.

The Model J1800 is a much larger device than the other Kelsey Centrifugal Jigs, the central bowl has a diameter of 1800mm with over twice the capacity of the smaller units. The internal screen area has over twice the surface area of the next smallest model the J1300.

Cast iron launders and inclined operation result in the unit requiring the smallest footprint possible for compact installations.

Operator involvement is now only about 0.25hrs per day, which includes general housekeeping of the circuit. This figure is dramatically reduced on multiple installations.

Acknowledgements

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Conclusion

A substantial level of interest has been shown already by the mining industry for this more robust and economic Kelsey Jig. It is anticipated that this level of interest will continue to intensify with installations world wide.

References

1. Tucker, P. (1994) Modelling the Kelsey Centrifugal Jig
2. Silva, E.C. (1999) Centrifugal Concentrators – A New Era in Gravity Concentration – The Experience of CVRD Research Center