A NEW GENERATION OF KNELSON CONCENTRATORS A TOTALLY SECURE SYSTEM GOES ON LINE

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"A NEW GENERATION OF KNELSON CONCENTRATORS"
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ABSTRACT

This paper briefly outlines some of the traditional gravity devices commonly utilized in precious metal recovery mill systems. It summarises the development of the centrifugal concentrator and features the problem of overcoming the retention of values while vastly increasing g force. The principals of the Standard Knelson Concentrator are explained and the Centre Discharge model is introduced that provides a totally secure gravity system. Reference is also made to the development of the Continuous Knelson Concentrator designed for the concentration of base metals and segregation of contaminating elements from finely classified coal. Special attention is given to sampling for free milling precious metals, the correct orientation of Knelson Concentrators in a gravity circuit and the economic advantages that can be expected.

Keywords

Gravity concentration; total security; continuous concentration; precious and base metals; coal contaminants; sampling; orientation.

INTRODUCTION

Gravity concentration of precious metal, particularly gold in placer operations, has relied entirely on the use of the sluice box for hundreds of years. Even today the preponderance of sluice boxes used in North American and elsewhere is evident. Although proprietary production size designs are marketed, the variety of sluice box designs are only slightly exceeded by the number of sluice box operations! Rather than being a science, sluice design was, and still is, a rather dubious art. Probably, the only universal design is the pinch sluice which more accurately should be termed a nugget trap as it is only utilized for and primarily capable of recovering course free milling values. The advent of jigs, spirals, cones and a number of other single gravitational recovery devices have certainly made their mark in the industry and were the result of concerted efforts in research to improve gravity recovery. The invention of the single wall centrifugal concentrator some fifty years ago in the form of a spinning bowl was a move in the right direction. Generally speaking, however, all the latter devices operate in a narrowly sized feed range and pulp density is critical. Due to the narrow sizing problem, an array of apparatus is commonly used to achieve gravity recovery. These circuits fed by cyclones may include sluices, jigs, spirals and cones all producing concentrates, in a very insecure atmosphere, that require further treatment. In terms of space, purchase price, installation cost, energy and recovery efficiency, these installations are costly.

The originators of centrifugal concentrators were faced with the problem of finding a way to increase the gravitational force that would contribute to higher throughput and better classification by specific gravity. The problem was that, as the gravitational effect increased the efficient operational period for the device was greatly reduced due to premature packing of the concentrating bed. This in turn resulted in serious loss of values. As an example, one currently produced spinning bowl that operates at some 300 g's must maintain a critical 15% pulp density and a minus 30 mesh feed. The device performs well but only for a limited time that rarely exceeds 15 minutes before values commence tailing. The first and only single wall centrifugal device that permitted prolonged operation without packing was the barrel concentrator that operated at a maximum of 5 g's. The problem with this device was that it produced a very large volume of concentrate in relation to throughput. The classification of materials of closely related specific gravities was also difficult to define due to the low g force. Centrifugal concentrators therefore achieved little market penetration in both the hardrock and placer industries until quite recently.

About 12 years ago Knelson Gold Concentrators Inc. solved the problem of increasing the centrifugal force in a spinning bowl while retaining fluidization of the concentrating bed. This allowed extended operational performance and the retention of extremely fine particulate values. As g force is a product of energy, it was then a matter of determining the optimum force necessary to make a well defined separation between materials of close specific gravities. The g force was determined at 60 g's and the rest of the story is history. The Knelson Concentrator, or KC™ is now to be found in over 50 countries and account for nearly 800 separate installations.

It would be superfluous to dwell too long on the subject of how the KC works but a short explanation is necessary to fully understand its unique qualities and what it can accomplish for you, the mill operator.

THE STANDARD MODEL KNELSON CONCENTRATOR.

The standard model KC is a centrifuge that develops 60 g's and classifies a feed of 6 mm or less by specific gravity. (Figure 1) The feed is introduced to the concentrator by gravity through a vertical tube (A) to the base of the rotating bowl. The feed, as a slurry, only requires enough water to transport it but any density from zero to 70% can be handled without any detrimental effect to operational efficiency. At the base of the bowl is a replaceable wear pad (B) on to which the feed falls and where it is immediately propelled to the perimeter and rapidly gains speed. As the energy of the feed increases and gains vertical momentum it charges the concentrating rings with gangue and progresses upwards and over the rim of the bowl to the tailing launder (C). Centrifugal force that would cause packing of material in the rings is offset by the injection of balanced water pressure derived from the surrounding water jacket (D). The water is pumped to the unit by way of a special union at the base of the hollow drive shaft (E) that propels the concentrator. The resulting fluid bed behaves as a heavy liquid whose density is that of the pulp and a hindered settling condition prevails. The efficiency of the fluid bed is increased by the water being injected tangentially and opposed to the rotational direction of the bowl. It is in this constantly agitated environment that classification takes place with the particles of higher specific gravity displacing those of less and imbedding themselves in the interstices of the gangue and thus concentration takes place. The duration of concentration is a factor of feed grade and time and concentration ratios are extremely high as the actual volume of concentrate produced is very low and smelter grades can be produced.

The standard KC is a batch machine and feed must be diverted while the removal of concentrate takes place. This exercise takes ten to fifteen minutes and is accomplished by unlocking an access door, removing a drain plug and flushing the concentrate via pipeline to a secure goldroom or container.

Operating procedures are very simple as the KC operates at a constant speed. Fluidizing water pressure is the only variable factor and tuning can be accomplished in minutes. An unspecified but "normal" or "average" quantity of suspended solids in the fluidization water can be tolerated by the KC and is automatically concentrated in the water jacket and ejected on a continuous basis to the tailing launder. Every KC is also equipped with a back-up "on line" filter that can be purged while operating.

The Knelson Concentrator requires little maintenance. It is sturdily built and has only one moving part, the drive shaft that passes through two pillow-block bearings. Those areas subject to high abrasion are lined with wear resistant materials and considerable over design is used to assure the owner of dependable service. It is optional for wetted surfaces to be made of stainless steel. The concentrating bowl, in all cases is moulded with a wear resistant polyurethane.

Table 1 shows the five standard KC models presently built together with minimal operating specifications. More detailed specification sheets are available with general purpose drawings.

STANDARD KNELSON CONCENTRATORS					
SIZE ins (cm)	POWER REQMNT hp (kw)	MAX FEED CAPACITY lblstph (kg/mtph)	MAX FEED SIZE ins (mm)	MAX FEED WATER USgpm (lpm)	MAX CONCENTRATE OL/WT ins^3/lbs (1 /kg)
3 (7.5)	116 (0.15)	1001 (45/)	0.065 (1.7)	4 (15)	4.110.5 (0.067/0.225)
7.5 (19)	0.75 (0.50)	IO.75 (/0.68)	0.1875 (4.7)	30 (115)	53.7/5.0 (0.88/2.3)
12 (30)	1.5 (1.20)	14.0 (/3.6)	0.25 (6.4)	40 (160)	166/I 2.0 (2.72/5.5)
20 (50)	5.0 (3.75)	/1 5.0 U13.6)	0.25 (6.4)	120 (450)	561/40 (9.2/I 8)
30 (75)	10.0 7.50)	140.0 U38.3)	0.25 (6.4)	175 (665)	1071/80 (17.6/36)

Note: Metric equivalents are approximate.

TABLE 1.

THE CD MODEL KNELSON CONCENTRATOR

A more recent addition to the Knelson line of concentrators is the CD model or Centre Discharge unit. This model is manufactured in the three production sizes only, i.e., 12” (30 cm), 20” (50 cm) and 30” (75 cm). The CD can be totally automated and integrated into any existing computerized circuit. It provides the mill operator with a “Hands Off” secure system while providing the same degree of recovery of free milling gold or other precious metals as the standard unit.

Fundamentally the CD unit is identical to the standard unit but for three important innovations. (FIGURE 2.) They are the shape of the concentrating bowl, the addition of a dual purpose hub directly below the bowl and a feed deflector below the point of feed injection.

The CD series removal of concentrate can be accomplished automatically in less than two minutes. The sequence includes diversion of feed to the ball mill, reduction of fluidizing water pressure and the speed of bowl rotation. As the speed of rotation falls, the concentrate is flushed from the concentrating rings past the feed deflector and piped directly to a secure goldroom. Thence rotational speed and fluidization water pressure are resumed and the feed is directed back to the concentrator. Mill operators with CD units on line report that the short feed diversion presents no problem.

The addition of a passive screen with horizontally slotted openings over which the feed passes before entering the concentrator allows the mill flattened gold to report to the concentrator while the oversize, including tramp metal, merge with the tails and report back to the ball mill.

Installations of the CD Model Knelson Concentrator are now on line in Canada, USA, Australia and Ghana.

THE CONTINUOUS KNELSON CONCENTRATOR.

A continuously operating KC is being developed. This unit is specifically designed for the base metal and coal industries. Base metal concentrators are being designed to concentrate percentages of ore rather than grams per tonne as required with precious metals. The units designed to separate the fine fractions of sulphides and ash from coal are progressing and recent tests carried out by the Canadian Minerals and Energy Testing facility at Devon, Alberta are promising.

ORIENTATION OF THE KNELSON CONCENTRATOR.

The Knelson Concentrators ability to recover fine particulate precious metals had originally suggested that it should be used as a scavenger unit to recover values lost by the jigs, spirals and tables, etc., or even to process tails from floatation. This hypothesis has been rejected in place of locating the KC immediately downstream from the underflow of the primary cyclone circuit. This is supported by 95% of installations to date and by recent studies. [1] These studies suggest that locating the KC within the grinding circuit eliminates the need of other gravity recovery devices.[2] This contention is based on the fact that the KC will accept feed in any size below 6 mm without detrimentally affecting recovery. However, most material fed to KC circuits pass 1.65 mm or less to eliminate tramp metal over this size that might be problematical.

ASSAYING FOR FREE GOLD AND OTHER PRECIOUS METALS.

Where recovery is essentially made by floatation &/or by dissolution in cyanide solution, it is common practice to assay for free milling values by cutting a sample from a point where the milling process has reduced the material to the smallest economical particle size. While this probability technique, based on frequency, provides acceptable assays for leaching or floatation it does not give an accurate assay of free milling precious metals. The latter values are disseminated with such irregularity that the high assays that are occasionally found are dismissed as aberrations and the traces or total lack of economic values become the considered probability. [1] It has been firmly established that assaying for free milling values can only be accurately determined by continuous sampling. More specifically, sampling must be at the underflow of the primary cyclone circuit where normally the course fraction reports back to the ball mill. This regrinding process tends to further flatten these malleable precious metals and smear them onto gangue particles. These smeared particles produced by inefficient and costly grinding kinetics pass unrecognised by floatation to tails. Although these values can be recovered by chemical dissolution, the regrind process and additional chemical consumption has been found to be a significant cost factor.

CONCLUSION

Location of the Knelson Concentrators within the grinding circuit can replace an array of other gravity systems due to the extensive particle sizes it will efficiently process. [1] Mill operators can expect a number of economic advantages that can be categorised as follows:[2]

1. Improved gravity recovery of mill flattened values including those normally lost in tabling.
2. Lower grades reporting to floatation &/or leach circuits.
3. Improved leach kinetics.
4. Less solution and solid residues, and
5. Improvement in overall plant recovery,.

Cost benefits gained from lowered carbon stripping requirements and consequent reduction in cyanide, acid, energy and water can be translated into additional savings.[3] The inclusion of Knelson Concentrators in new plant design will save floor space and in cold countries reduce heating loads.

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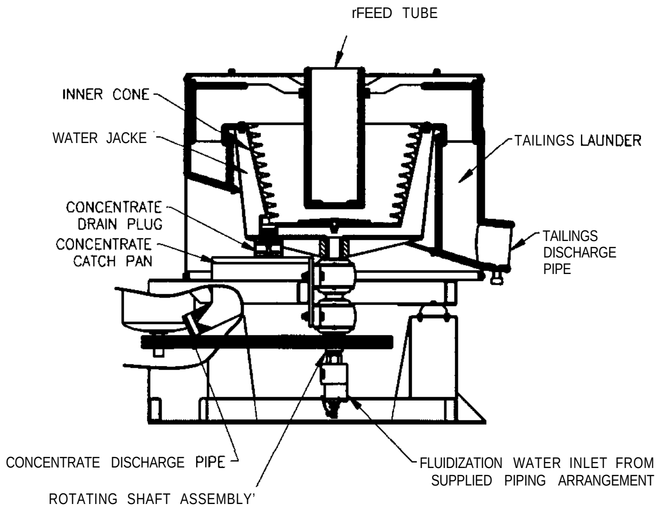
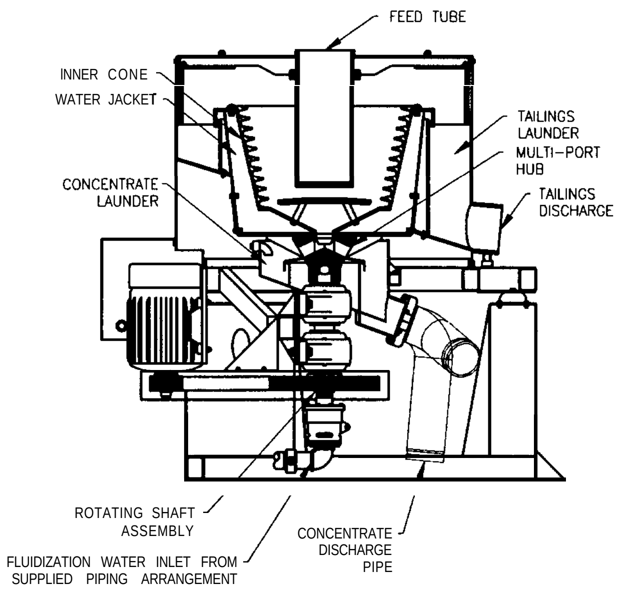
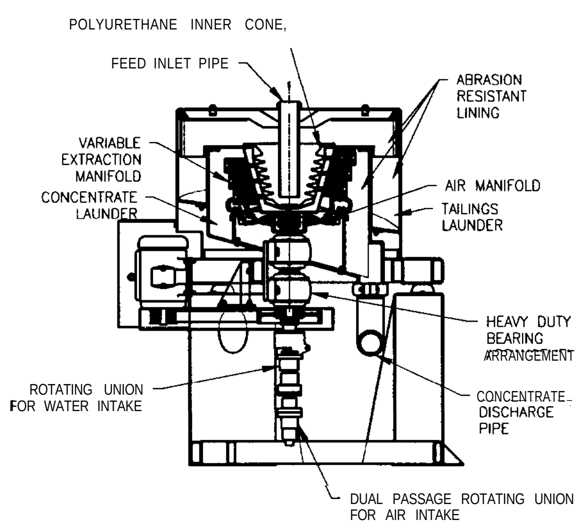


30" KNELSON CONCENTRATOR SECTION DRAWING (FIGURE 1)



30" KNELSON CENTRE DISCHARGE CONCENTRATOR SECTION DRAWING (FIGURE 2)



12" KNELSON VARIABLE DISCHARGE CONCENTRATOR SECTION DRAWING (FIGURE 3)

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KNELSON SECTION DRAWINGS ON VARIOUS MODELS OF CONCENTRATORS — FIGURES 1–3