Spiral concentrator

Environment, Water

Chapter 1. Spiral §1. 1 Spiral A spiral concentrator uses gravity to separate particles of different densities. It is used globally in the mineral processing industry. It is one of the most effective, low-cost devices for the gravity beneficiation of ores.

Manufactured from lightweight, corrosion and abrasion resistant materials, spirals require a minimum of maintenance and upkeep. Consists of an open trough that twists downward in helix configuration about a central axis. Particles fed to the top of the concentrator are separtated radially on the basis of density and size as the slurry gravitates downward. Spirals are made of fiberglass onto which smooth urethane surface is molded to form a trough in the shape of a spiral as the name suggests. Between individual spiral types, the profile of the trough and the pitch as well as the diameter and height and number of turns can vary according to duty. Feed slurry is introduced at the top and is subjected to a combination of gravitational and centrifugal forces imparted by its motion down the spiral. This causes high SG minerals to move towards the centre of the trough and water and low SG minerals towards the outside.

The segregated slurry discharging from the spiral at the bottom can thus be separated by cutters into high SG (concentrate) and low SG (tailings) together with intermediate SG (middling). Single Start Spiral §1. 2 Applications of Spirals Spiral concentrators have, over numerous years, found many varied applications in mineral processing, but perhaps their most extensive usage has been in the treatment of heavy mineral sand deposits, such as those carrying ilmenite, rutile, zircon, and monazite, and in recent years in the recovery of fine coal. Spirals are commonly used to separate sand sized particles with moderate SG differential in the range -2mm +75um, although varieties exist that can separate reasonably efficiently down to 38um. Below this size range efficiency falls off rapidly, and enhanced fine gravity separators are generally required. Applications for spiral separators • Mineral Sands • Iron ore • Chromite • Silica Sands • Coal • Gold • Others Spiral components ? Modular feedbox ? Splitters ? Repulpers ? Product box Modular feedbox – The feed point to a spiral separator is an area where the feed slurry is normally relatively fast flowing. The duty of the feedbox is to dissipate some of the energy in the feed slurry and present the feed to the top of the separation trough in a homogenous and quiescent slurry distributed across the width of the spiral trough.

The modular feed box system achieves this objective with replaceable componentry that can withstand a high impact abrasion. [pic] Splitters- Each spiral start has six concentrate collection splitters which direct the concentrate into the inboard collection trough. These splitter mechanisms are designed for easy adjustment and repeatable positioning (using a graduated scale). They have a positive splitter-to-spiral seal and are able to handle a high volume of concentrate. All splitter handle indicators are readily visible so that the operator s can see and adjust large numbers of handles accurately and quickly. The splitter is used to direct the particles to their respective discharge ports. At the end of the spiral there is a Splitter and discharge part Repulpers – The installation of repulpers on spiral troughs improves the separation efficiency of spiral separators.

The function of repulpers is to capture and divert a portion of water from the high velocity tailing stream and introduce it to the relatively sluggish middling stream in order fluidise the particle bed and re-initiate separation mechanisms . Repulper to Direct water from Outer Spiral Wall To concentrate collection area Product Box- The collection and laundering of the product fractions from spirals (concentrators, middlings, tailings) is facilitated by product boxes which are designed to collect common fractions from the separating troughs of multi- start spiral separators. The design of this feature is critical to ensure the effective directional change and joining of fast-moving slurries whilst minimizing splash and impact abrasion. [pic] §1. 3 Spiral Operation [pic] Cross section of a spiral concentrator divided into various regions A cross section of a spiral concentrator can be divided into various regions, with each region describing the effect it has on the slurry traveling through it : ? On the outer most region (1) (perimeter), will have mostly water, with fine particles, trapped by the high velocity of the moving water. Moving inward towards the center of the spiral, the next region(2) would consist of a very small area where the maximum water velocity exists, and prevents any separation to occur. This region is defined since it separates the next region (3) from the first region ? Region 3 is a very active region where the velocity begins to slow down and most of the separation occurs, as more dense particles settle to the bottom and the water velocity keeps the light density particles in the stream near the surface, where they eventually wind up in the outer regions (2 and 1).

The next region (region 4) is actually where two regions overlap (region 3 and 5), and is a very narrow region (like region 2). ? Next to the last region

(region 5) is where the heavy density concentrates collect Working Principle of Spiral Concentrators: In order to have a good separation, there should be a difference in Specific Gravity's of at least 1. 0. One main benefit of spiral concentrators is they have no moving parts. The feed range, in percent solids, to a spiral ranges from 20% solids up to 40% solids. Depending upon the material characteristics, a maximum efficiency will usually be reached somewhere in this range. All that is required are some slurry pumps, the slurry to be separated and the banks of spirals with a feed distributor.

? Slurry is pumped to the top of the spiral (typically 13' to 15' from the floor), and it enters a feed distributor that evenly distributes the feed to each spiral concentrator. The design and shape of the spiral make it work, when combined with gravitational acceleration. ? As the slurry travels the spiraling path down the spiral, mineral grains settle and start sorting according to size, density and to a lesser extend shape. Low density particles are carried with the bulk of the water towards the outside of the spiral (perimeter), while particles with the greatest density migrate towards the inside of the spiral Chapter 2 Types of Spirals §2. 1 Types of Spirals ? Washwaterless Spirals This type of spiral is used in most applications, particularly for concentrating low-grade ores. The only water required is added with the solids prior to introducing feed onto the spiral. Concentrates are removed either at the bottom directly into the product box or at several intermediate take-off points down the spiral.

? Coal/Mica SpiralsLarger in diameter than mineral-type spirals, these spirals are designed to take advantage of the particle shape differences as well as specific gravity differences. Take-off splitters at different points down the helix give this spiral a high capacity to remove refuse ore and siliceous contaminants from the coal or the mica. ? Washwater Spirals Washwater spirals require the addition of water at various points down the spiral providing more efficient washing of the concentrate, i. e. , transporting away light gangue (silica) from the concentrate band Standard Spiral Separators – Typically treat 2tph per start Have 3 starts per assembly (attached to one column) – Tonnage per assembly is 6tph ? High Capacity Spirals – Treat up to 5tph per start – Have 4 starts per assembly – Tonnage per Assembly is 20tph High Capacity Spiral (Rougher and Scavenger) High Capacity Spiral Fine Mineral Spiral Standard Spiral Standard High Grade Spiral New High Grade Spiral §2. 2 Benefits of the use of Spirals ? One main benefit of spiral concentrators is that they have no moving parts; ? To treat more material in less floor area; ? Low maintenance and simplicity; ? Higher separation efficiency than pinched sluice devices Chapter 3 Geometric and Operational ParametersGeometric Parameters Geometrical variables: ? Diameter ? Pitch ? Down trough slope Some of these factors are interdependent. In general, recent design spiral separator have complex geometrical trough profiles that change throughout the length of the spiral trough.

Diameter The trough diameter impacts on the trough profiles and downtrough slope and thence scale-up for higher capacity is not a trivial geometrical exercise Pitch The pitch (vertical distance between successive turns) determines the down trough slope and slurry velocity. This factor also influences the residence time of the feed slurry as does the number of turns. Down slope The slope can effect the velocity of the slurry moving through the spiral. The steeper the slope the higher the slurry velocity. | Model | 5LL-1200 | 5LL-900 | 5LL-600 | 5LL-400 | | Chute Outside Diameter(mm) | 1200 | 900 | 600 | 400 | | Qitch(mm) | 900, 720, 540 | 675, 540, 405 | 450, 360, 270 | 240, 180 | | Ration of Qitch to Diameter | 0. 5, 0. 6, 0.

45 | 0. 75, 0. 6, 0. 45 | 0. 75, 0. 6, 0. 45 | 0.

6, 0. 45 | | Lateral Slope | 9° | 9° | 9° | 9° | | Max Number of Spirals | 4 | 4 | 3 | 2 | | Feed Size(mm) | 0. 3-0. 03 | 0. 3-0. 03 | 0. 2-0.

02 | 0. 2-0. 2 | | Feed Density(%) | 25-55 | 25-55 | 25-55 | 25-55 | | Capacity(T/h) | 4-6 | 2-3 | 0. 8-1. 2 | 0. 15-0. 2 | | Dimention | Length(mm) | 1360 | 1060 | 700 | Operational Parameters Operational variables: ? Slurry velocity ? Amount of slurry ? Amount of water Each parameter improves the impact on the other.

The amount of water improves the amount of slurry and the Slurry velocity. The slurry velocity also depends on the density, mass and the viscosity of the materialThe amount of water effects the slurry viscosity . If the amount of water increases the flow- rate of the slurry increases. Conclusion The wide variety of spiral separator models now available provides a selection of models that ensures most applications where gravity separation of fine minerals can be utilized. The use of spiral concentrators benefits low-cost process plant . Further benefits to operators of mineral processing plants incorporating spiral separators include: • Efficient feed distribution and products laundering systems • Ease of control • Low maintenance and long service life • The availability of circuit modeling systems • Simplified plant operation The ongoing development effort to improve the metallurgical performance and capacity of spiral separators for specific duties has effectively extended the product life cycle of this gravity separation device.