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Note

Enhanced gravity separation at the Mineral Processing Laboratory at NTNU

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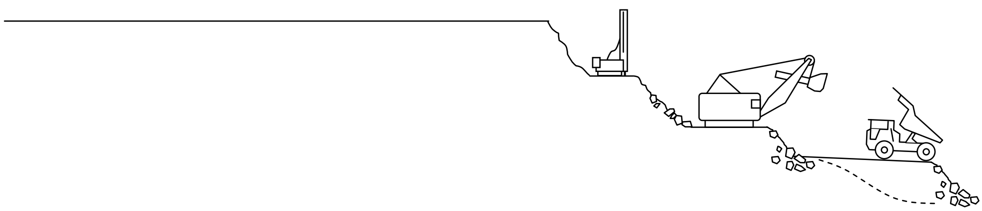
The mineral processing laboratory at IGB offers the industry a wide range of laboratory and pilot scale equipment within comminution, classification and physical separation techniques. This publication deals with the more modern enhanced gravity concentrators (EGC's) like the Mozley Multi-Gravity Separator (MGS), the Kelsey Jig and the Knelson Concentrator.



1. INTRODUCTION

The mineral processing laboratory offers both traditional gravity separation equipment and enhanced gravity concentrators. The traditional gravity separation equipment are laboratory shaking tables like the Mozley Laboratory Mineral Separator, a traditional Wilfley table, and a laboratory jig, while the pilot equipment consists of a larger Wilfley table and a spiral rig system from Insmart Systems. Our enhanced gravity concentrators are the Knelson Concentrators KC-MD3 and KC-MD7.5, the Kelsey Jig J200 and the Mozley C900 Multi-Gravity Separator (MGS). The Knelson Concentrators are batch separators (laboratory and pilot scale), while the Kelsey Jig and the Mozley MGS are continuous pilot scale processing equipment.

Enhanced gravity concentrators (EGC's) are wet centrifugal separators that use centrifugal force to enhance the settling rate of particles. In an EGC the centrifugal force is generated by rotating the separating chamber itself, which means that the separation is primarily based on the relative settling velocity differential between the particles. These gravity separators are capable of upgrading particles down to 1 μm, and have a tremendous potential for various applications, as they are able to take care of fines, enhance quality and/or yield of products, and in certain cases can substitute for other types of mineral separation processes.

2. ENHANCED GRAVITY CONCENTRATORS AT IGB

2.1 Mozley C900 Multi-Gravity Separator (MGS)

The Mozley C900 MGS consists basically of a slightly conical open ended drum that rotates and in the same time shakes sinusoidally in an axial direction (fig. 1). Inside is a scraper assembly wich rotates in the same direction but at a slightly faster speed. Feed slurry and washwater is introduced onto the internal surface of the drum, and as a result of the centrifugal forces (up to 22G) and the shaking motion the dense particles move towards the open end of the drum and the concentrate discharge, while the light particles are carried to the rear end of the drum and the tailings discharge.

The MGS C900 is suitable for the treatment of fines and ultrafines down to a lower particle size of approximately 1 μm. It has a maximum capacity of 200 kg/hour, but is normally operated at 30-100 kg/hour depending on feed and wanted quality of product. Although it is continuous operation, it can be run in batch mode with as low as 500 gram batches. Adjustable test parameters are feed particle size distribution, feed rate, pulp density, washwater rate, rotational speed, tilt angle, shake speed and shake amplitude.

Figure 1. Mozley C900 MGS (left) and inside drum scraper assembly and feed system (right).

2.2 Knelson Concentrator

The Knelson centrifugal concentrator consists of a rotating ring-shaped cone that can produce centrifugal forces of 60G (fig. 2). The feed slurry is introduced through a central feed pipe and flows counter-current from ring to ring until the slurry water phase and light particles overflows the uppermost ring and discharges through the tailings outlet. Rinsing water is at the same time forced counter-current through perforations in the bottom of each ring of the cone, causing the settled layer to fluidize and allow for dense particles with higher mobility than light particles to trickle into the sediment layer. In this way the dense minerals displace the light minerals which are pushed upwards in the cone and finally go out together with the overflow water. The separation mechanisms can be described as a difference in mobility between light and heavy particles (Bagnold 1954) and as a result of a hindered settling classification (Burt 1992).

Adjustable test parameters are feed particle size distribution, feed rate, pulp density, washwater rate and rotational speed.

Figure 2. Knelson Concentrator (left) and inside concentrating cone with sediment layer (right).

2.3 Kelsey Jig J200

The Kelsey jig is able to recover particles that are too fine to be recovered by conventional jigs, shaking tables and spirals. It is essentially a Harz jig placed vertically in a centrifugal field (Malvik et al. 1997), and consists of a rotating “cylinder” with a series of individual hutches placed around it (fig. 3). The hutches hold the pulse water, created by a diaphragm, and discharge concentrate through their spigots (valves). Within the cylinder a cylindrical screen is placed in order to retain the ragging bed. Screen size and ragging size distribution are selected with basis in the feed size distribution, while ragging material is selected with basis in the tailings and concentrate densities. The ragging material shall have a specific density that lies between the densities of the heavy and the light materials. The screen size must be small enough to retain the ragging bed and large enough to let through the heavy particles.

The feed enters from the top and the centrifugal force (up to 100G) sends the material radially towards the ragging bed. The mechanical pulsation of the jig creates oscillations that make the ragging bed to dilate and contract, which in turn results in differential acceleration of the feed and ragging particles according to their specific density. High density particles pass through the ragging and screen and are discharged through the spigots, while light density particles overflow the ragging and the top of the unit.

The capacity of the J200 is maximum 100 kg/hour. Adjustable test parameters are feed rate, washwater rate, screen size, ragging size distribution, ragging density, ragging bed depth, rotational speed, stroke length and stroke frequency. Among these Yerriswamy et al. (2003) considered the rotational speed, ragging characteristics and stroke length to be the major operating variables.

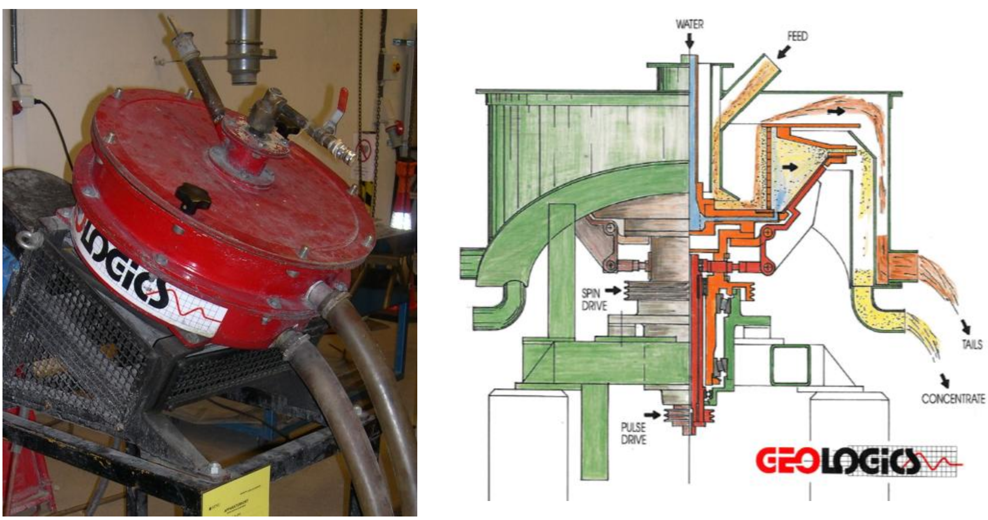


Figure 3. Kelsey Jig J200 (left) and principle of operation (right).

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