

CHAPTER 1.

INTRODUCTION

Dense medium cyclones are used extensively in the mineral processing industry to beneficiate various minerals including coal, diamonds and iron ore amongst others. According to Reeves (2002), “the cyclone has been installed in over one-quarter of the coal preparation plants worldwide”. Further, de Korte (2000) reported that about 93% of the 58 coal preparation plants in South Africa employed dense medium cyclones. The structure of a dense medium cyclone is illustrated in Fig. 1.1. This equipment separates minerals according to their differences in densities, whereby the heavier particles are sent to the sinks and the light particles to the floats. Feed enters tangentially through the inlet under high pressure so that a vortex is created within the cyclone. Consequently, an air core that extends from the floats through to the sinks along the axis of the cyclone is developed. The inward vortex carries the floats particles to the floats stream and the outward vortex carries the sinks particle to the sinks stream. A slurry mixture of ore particles and an aqueous suspension of very fine medium particles constitute the feed slurry. Cyclone feed is normally de-slimed beforehand to remove fines, typically smaller than 0.5mm, which would have an adverse effect on the medium quality and cyclone performance (Reeves, 2002).

Other centrifugal dense medium separators, which operate on a principle similar to dense medium cyclones, include LARCODEMS, Vorsyl and Dyna Whirlpool separators. LARCODEMS and Dyna Whirlpool separators have been widely used to beneficiate larger particle sizes that are thought to be too large for cyclones (Reeves, 2002).

Dense medium cyclones are usually installed at a near horizontal inclination angle to allow usage of relatively large spigot sizes for sinks removal, and drainage of the cyclone contents during shutdown. This inclination angle is typically 10 degrees to the horizontal.

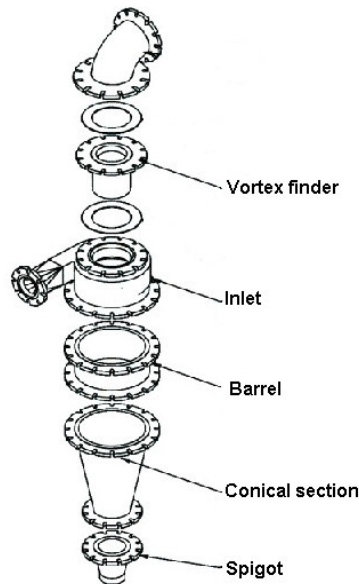


Figure 1.1. Cyclone geometry. (Adapted from Bosman 2003b)

The medium particles can either be magnetite (SG 5.1) or ferrosilicon (SG 7.0). Magnetite is employed as medium mainly in coal preparation, while ferrosilicon is employed for other minerals/valuables such as diamonds and iron ore. There are two types of ferrosilicon namely: milled and atomized (Fig. 1.2. (a) and (b)). Milled ferrosilicon is used at medium density ranges between 2.0 and 3.0RD, while atomized ferrosilicon is employed at densities between 3.0 and 4.2RD (Smith, 1989 and Grobler, 2006). The application range of magnetite is typically between 1.3 and 2.0RD.

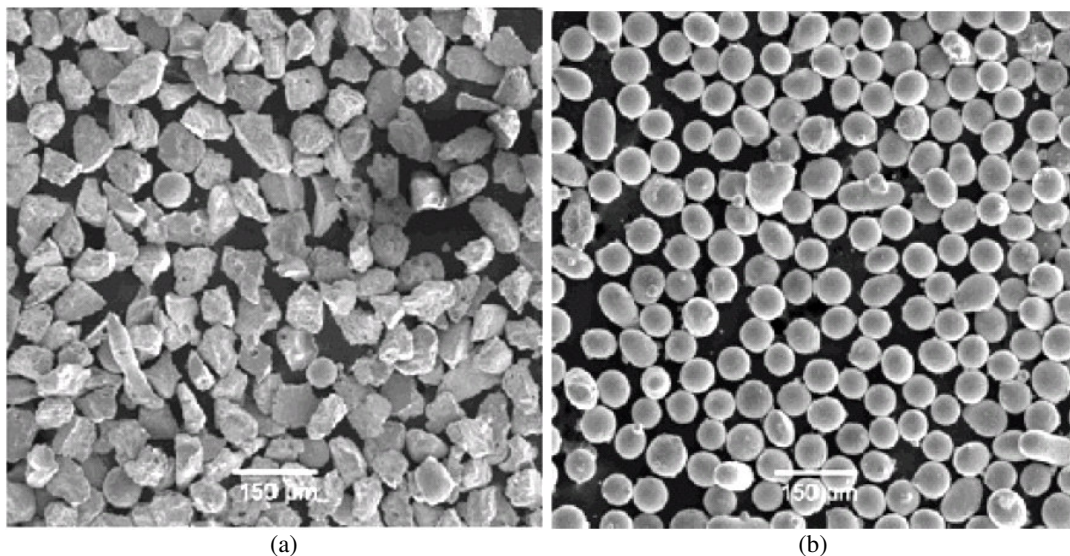


Figure 1.2. Milled and atomized ferrosilicon. (Grobler, 2006)

Dense medium cyclones have the ability to achieve high capacities, and simultaneously obtain sharp separations and high separation efficiencies. However, this piece of equipment does have a shortcoming in that its capacity is constrained by the solids carrying capacity of the spigot. This is termed the spigot capacity. Once the spigot capacity is exceeded, the separation efficiency of the cyclone suffers. In applications whereby relatively large quantities of the feed material exit through the sinks, the spigot acts as a ‘bottleneck’ (Bosman, 2003a). In such instances it becomes necessary to install larger or more cyclones in order to achieve the required sinks capacity. According to Peatfield (2003), the capacity of cyclones treating low yield coals is influenced mostly by the medium-to-ore ratio and the rejection capacity of the cyclone spigot.

Manufacturers guidelines such as those provided by the original developers of the dense medium cyclone, Dutch State Mines (DSM) in the so-called DSM handbook, normally specify the spigot capacity for a cyclone of a particular size. Due to the fact that the DSM guidelines “left no issue in doubt” and the dense medium cyclone performed as guaranteed when the DSM guidelines were followed (Moorhead and Schutte, 2005), the specified spigot capacities have been widely accepted; although there is uncertainty with regard to how these capacities were determined and whether they can be increased. The purpose of this study is to establish a methodology to determine the spigot capacities of dense medium cyclones, and determine the parameters that influence these capacities.

In order to illustrate the significance of increasing the capacity of dense medium cyclones, the following coal example is used. In 2005, South Africa produced about 245Mt of coal valued at R35.86 billion according to DME (2005). A significant proportion of this coal is beneficiated through dense medium cyclones. Therefore, an increase in the cyclone capacity, even if relatively small, represents a large number in terms of tonnages of coal produced or monetary gains.