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THE ROLE OF DEWATERING SCREEN FOR FINE FRACTIONS SIEVING IN DMS PROCESS – A CASE STUDY

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Abstract

This paper presents a description of dewatering screen construction and its working principle, as well as an example of dewatering screen application in the process of dense media separation. In addition, calculation method of one dewatering screen is given, based on realistic assumed parameters.
Keywords: *dewatering screen, dense media separation, calculation*

1. INTRODUCTION

Vibrating screens are widely used for dewatering bulk materials. For example, it can be coal, sand, ores, raw materials in the ceramics industries, granular plastics and intermediate products in the chemical industries [1]. According to Ettmayr et al, typical throughputs range up to more than 100 t/h. They also state that these machines are generally simple and robust, thus keeping rather low capital cost, downtimes and maintenance costs [1].

Dewatering screens have a wide variety of application including dewatering, desliming, rinsing, scrubbing and washing. They are made up of screen cloth, vibration exciter, supporting system and motor [2]

Depending on screening requirements, different screen inclination angles are employed. The upward-designed screen inclination angle forms a slurry pool at the feed end, and the static pressure head facilitates the slurry to pass through the screen, resulting in a large material processing capacity [3].

To dewater material effectively, slurry is fed onto a steep, downward inclined screen surface at the feed end of the dewatering screen to achieve rapid drainage. A pool of water begin forms in the valley as material builds up on the slightly upward inclined surface. Counter-rotating vibratory motors (or mechanical exciters on the largest of dewatering screens) create a linear motion at an angle to the screen surface that accelerates the solids upward and forward at 5 G. This, along with a generous stroke length, moves water through the countless openings between the particles to promote droplet formation [4].

The abrupt reversal of motion detaches water from the material, and the water droplets pass through the screen media. The solids are conveyed up the screen by this linear motion. The uphill slope of the screen, along with a discharge weir, creates a deep bed that acts as a filter medium, allowing retention of material much finer than the screen openings. A thick bed of material promotes fine retention while allowing the water to migrate through [4]. Typical appearance of a dewatering screen for the dewatering of fine fractions (desliming) is given in Figure 1a. The layer of a drained material on the sieve is shown in Figure 1b.

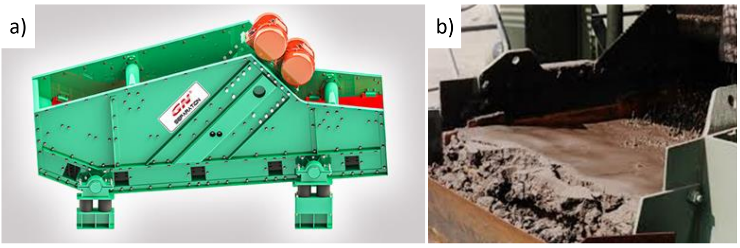

Figure 1: *a) Dewatering screen appearance where can be seen that the slope of the sieve is slightly upwards. b) Layer of drained material on the sieve. Adapted from [7] and [8]*

2. CASE STUDY

In the dense media separation (DMS) process, the fine fraction (the fraction that does not undergo the separation process) often first passes through the hydrocycloning stage, followed by a dewatering stage of cycloned underflow on vibratory dewatering screens, to reduce moisture content and turn it into a "cake" [5, 6]. Figure 2 shows a typical technological scheme for the dewatering of the fine fraction in the heavy media separation plant.

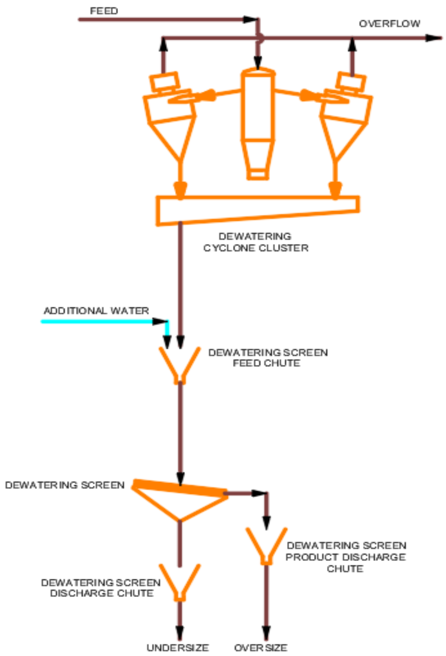

Figure 2. *Part of the DMS technological scheme including dewatering screen*

Small-sized ore, usually under 2 millimeters, is first transported to the hydrocyclone, where the finest ore fraction is deslimed, so that the finest material is separated in the overflow of the hydrocyclone in the form of sludge, while the underflow of the hydrocyclone is sent by gravity to the vibrating screen for dewatering. The oversize of the dewatering vibration screen is usually sent further to the process as a final product, while the undersize of dewatering screen is sent again to the classification circuit, i.e. to the hydrocyclone for desliming. In the following text, an example of dewatering screen calculation, based on assumed realistic parameters, will be given. The sieve calculation was performed according to the DSM (Dutch State Mines) methodology [3], and according to the methodology that includes capacity verification based on the height of the layer of material on the sieve.

Basic data for sieve calculation are:

- Production capacity	Q = 83,63 t/h
- Fluctuation coeficient	k = 1,2
- Maximum production	Q_{max} = 100,36 t/h
- Width of the screen deck	B = 1,53 m
- Lenght of the screen deck	L = 3,6 m
- Screen aperture	$a \times b$ = 0,5 × 12,5 mm
- Average particle size	D_{50} = 0,86 mm
- Solid density	ρ_s =3,09 t/m^3
- Bulk density of ore	γ = 2,2 t/m^3
- Sieve vibration frequency	f =1440 min^{-1}

DSM calculation method. Specific capacity of dewatering screen *(q)* which is expressed in t/h per meter of screen width can be determined according to the empirical formula:

$$q = C \cdot k \cdot \sqrt[3]{(d_{50} \cdot \rho_s)^2} = 19 \cdot 1{,}4 \cdot \sqrt[3]{(0{,}86 \cdot 3{,}09)^2} = 47{,}38 \frac{t}{h}/m$$

Where:

C –factor that depends on the purpose of the screen; in this case C = 19

k – factor that depends on the slope of the screen, for a given case k = 1.4

d_{50} – average particle size, mm

ρ_s – solid density, t/m^3

Dewatering screen capacity (Q) is calculated according to the expression:

$$Q = q \cdot B = 47{,}38 \cdot 1{,}53 = 72{,}50\ t/h$$

Where:

B – screen width, m

Considering that the actual capacity of the screen (Q = 327.08 t/h) is higher then necessery (Q = 264.00 t/h), it follows that the selected banana screen meets the projected conditions.

Calculation method based on the height of the layer of material on the sieve. The height of the layer of material on the sieve (h) can be determined using the following formula [9]:

$$h = \frac{Q}{3600 \cdot v \cdot B \cdot \gamma} = \frac{100{,}36}{3600 \cdot 0{,}15 \cdot 1{,}53 \cdot 2{,}2} = 0{,}055\ m/s$$

Where:

Q – maximum production capacity, t/h

v – speed of material on the sieve, m/s; for this type of sieve (dewatering) it is adopted v = 0,15 m/s

γ – bulk density of material, t/m^3

B – sieve width, m

The height of the material on the sieve, for the given maximum capacity (Q = 100.36 t/h), is 5.5 cm, which can be considered quite acceptable when it comes to dewatering sieves. It follows from this that the selected sieve sieve will satisfy the designed conditions.

3. CONCLUSIONS

Vibrating screens are widely used for dewatering bulk materials. For example, it can be coal, sand, ores, raw materials in the ceramics industries, granular plastics and intermediate products in the chemical industries.

To dewater material effectively, slurry is fed onto a steep, downward inclined screen surface at the feed end of the dewatering screen to achieve rapid drainage. A pool of water begin forms in the valley as material builds up on the slightly upward inclined surface.

In DMS) process, the fine fraction often first passes through the hydrocycloning stage, and cycloned underflow goes to vibratory dewatering screen.

Dewatering screen calculation can be performed according to the DSM methodology, or by determination of height of the layer of material on the sieve.

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