The 55th International October Conference on Mining and Metallurgy
15 - 17 October 2024, Kladovo, Serbia
https://ioc.irmbor.co.rs

DOI: 10.5937/IOC24149J Original Scientific Paper-Mineral Processing

THE ROLE OF BANANA SCREEN IN DMS PROCESS – CASE STUDY

Ivana Jovanović[1a], Dragan Milanović[1b], Vesna Conić[1c], Tanja Stanković[1d], Miloš Janošević[1e]

[1]Mining and Metallurgy Institute Bor, Alberta Ajnštajna 1, 19210 Bor, Serbia
[1a] ivana.jovanovic@irmbor.co.rs, https://orcid.org/0000-0002-7450-6632;
[1b] dragan.milanovic@irmbor.co.rs, https://orcid.org/0000-0002-5589-9127;
[1c] vesna.conic@irmbor.co.rs, https://orcid.org/0000-0002-4268-3626;
[1d] tanja.stankovic@irmbor.co.rs, https://orcid.org/0000-0002-2714-7016;
[1e] milos.janosevic@irmbor.co.rs, https://orcid.org/0000-0002-0818-1235

Abstract

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

1. INTRODUCTION

A banana vibrating screen is a specialized vibrating screen used in the mining and quarrying industries for sieving. Banana screen can be also applied in dense media separation (DMS) process for draining and rinsing of suspension. This screen is designed to be able to handle a high capacity of material, while also screening it to a very fine size. The banana screen gets its name from its shape, which is similar to that of a banana, with a curved surface at the feed end and a flat surface at the discharge end [1 – 3].

Banana screen is mainly composed of a screen box, screen mesh (net), vibration exciter, vibration-damping spring, and lower seat frame. The banana screen vibrate by a motor and an exciter. The exciter is mainly composed of an eccentric shaft, pulley, bearing, and bearing seat. The vibration exciter is installed on the side plate of the screen box and is connected to it by a motor through a V-belt or a soft connection. The motor drives the eccentric shaft to rotate, generating centrifugal inertial force, forcing the screen box to vibrate [2].

The working principle of a banana screen usually (but not necessarily) involves the use of multiple screen decks that are arranged at different angles to each other. The screen decks are typically instaled on a frame that is supported by springs or other flexible elements, which allow the screen to vibrate freely [1]. As the material to be screened is fed onto the screen deck, it is spread out evenly across the surface of the banana screen. The curved shape of the screen deck causes the material to move along the length of the screen, with the smaller particles passing through the apertures in the screen and the larger particles moving to the top of the screen. The slope of the screen changes from steep at the feed end to flat at the discharge end in order to maintain a constant bed thickness. [1, 4]. The vibration of the screen deck helps to loosen and stratify the material, separating it into different size fractions. The use of multiple screen decks at different angles helps to increase the screening area and improve the efficiency of the screening process [1]. Figure 1 shows appearance and material movement on banana screen. There are many models that describe the movement of material on a banana screen [5 – 7].

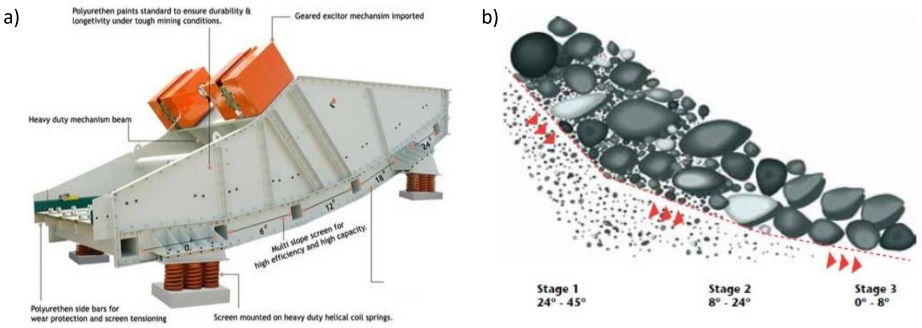

Figure 1. *Banana screen: a) overal apearance; b) material flow. Adapted from [8]*

One of the key advantages of the banana vibrating screen is its ability to handle a high capacity of material [1]. Banana screens are tipically known for their high capacity, efficiency, and reliability, and are often used in applications where large volumes of material need to be screened quickly and efficiently. They are also designed to handle a wide range of materials, including wet, sticky, or abrasive materials that can be difficult to screen when other types of vibrating screens are used [1].

2. CASE STUDY

Banana screens can also be applied in the DMS process for suspension removal from products separated by DM cyclone. An example is given in the Figure 2.

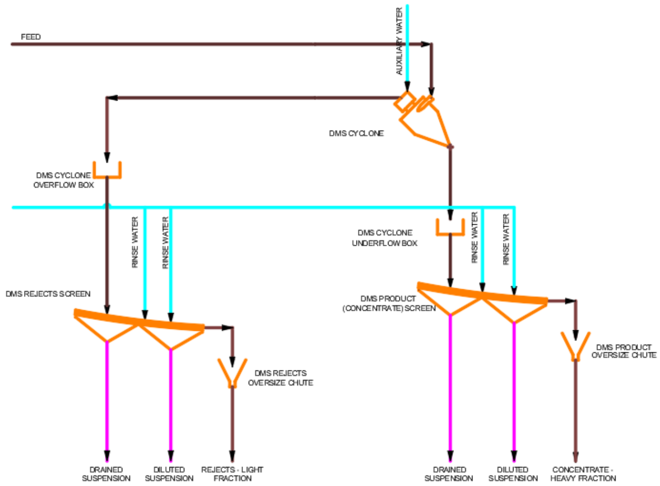

Figure 2. *Schematic of suspension removal from DM cyclone product by banana screens*

The DM cyclone is fed with material that is a mixture of ore and suspension. The heavy (sinking) ore fraction is separated as DM cyclone underflow. The light (floating) fraction of the ore is separated as an overflow of the DM cyclone.

DM cyclone underflow (sinking fraction) represents the concentrate of the dense media separation process and it is transported to the banana screen for concentrate, where the suspension is drained/rinsed. The concentrate first reaches the upper half of the banana screen, where only the suspension is drained off, without the addition of rinsing water. The drained suspension is further directed to regeneration. Thanks to the effect of vibrations and the force of gravity, the concentrate is further transported to the lower half of the banana screen, where, through sprinklers, washing water is added to rinse the suspension. The rinsed suspension, which is also the undersize of the lower half of the banana sieve, is further directed to regeneration. The exact same procedure takes place on the sieve for draining/rinsing the suspension from the light fraction, which represents the rejects of DMS process. In the following text, an example of banana screen calculation, based on assumed realistic parameters, will be given. The sieve calculation was performed according to the DSM (Dutch State Mines) methodology [3].

Basic data for sieve calculation are:

- Production capacity	Q = 220.0 t/h
- Fluctuation coeficient	k = 1.2
- Maximum production capacity	Q_{max} = 264.0 t/h
- Width of the screen deck	B = 2.50 m
- Lenght of the screen deck	L = 7.20 m
- Screen aperture	$a \times a$ = 0.8 × 0.8 mm
- Average particle size	d_{50} = 9 mm
- Solid density	ρ_s = 4.0 t/m^3

Specific capacity of banana screen (q) which is expressed in t/h per meter of screen width can be determined according to the empirical formula:

$$q = C \cdot k \cdot \sqrt[3]{(d_{50} \cdot \rho_s)^2} = 8 \cdot 1.5 \cdot \sqrt[3]{(9 \cdot 4)^2} = 130.83 \frac{t}{h}/m$$

Where:

C – factor that depends on the purpose of the screen and the type of suspenzoid; in this case C = 8 for drain and rinse screen purpose and suspenzoid ferrosilicon

k – banana factor that depends on the slope of the screen, for a given case k = 1.5

d_{50} – average particle size, mm

ρ_s – solid density, t/m^3

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

$$Q = q \cdot B = 130.83 \cdot 2.50 = 327.08\ t/h$$

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.

3. CONCLUSIONS

Banana vibrating screen is a specialized vibrating screen used in the mining and quarrying industries for sieving. Banana screen can be also applied in dense media separation (DMS) process for draining and rinsing of suspension.

The working principle of a banana screen is as following: Material is fed onto the screen deck, and spread out evenly across the surface of the banana screen. The curved shape of the deck causes the material to move along the length of the screen, with the smaller particles passing through the apertures in the screen and the larger particles moving to the top of the screen. The slope of the screen changes from steep at the feed end to flat at the discharge end in order to maintain a constant bed thickness.

In DMS process banana screens are often applied for suspension removal from products separated by DM cyclone.

Banana screen calculation can be performed according to the DSM (Dutch State Mines) methodology.

ACKNOWLEDGMENT

This work was financially supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, Grant No. 451-03-66/2024-03/200052

REFERENCES

[1] https://www.hsd-industry.com/news/working-principle-of-banana-vibrating-screen/
[2] https://www.lzzgchina.com/solutions/project-case/banana-screen-working-principle.html
[3] H. Crowden, B. Atkinson, C. Clarkson, B. Firth, M. O'Brien, D. Wiseman, C. Wood: ACARP Dense Medium Cyclone Handbook, Australian Coal Preparation Society, 2013. ISBN 978-0-9589344-2-8, 321 p.
[4] M. Jahani, A. Farzanegan, M. Noaparast: Investigation of screening performance of banana screens using LIGGGHTS DEM solver. Powder Technology 283 (2015) 32–47
[5] K.J. Dong, A.B. Yu, I. Brake: DEM simulation of particle flow on a multi-deck banana screen. Minerals Engineering 22 (2009) 910–920
[6] L. Chusheng, W. Hong, Z. Yuemin, Z. Lala, D. Hailin: DEM simulation of particle flow on a single deck banana screen. International Journal of Mining Science and Technology 23 (2013) 273–277
[7] P.W. Cleary, M.D. Sinnott, R.D. Morrison: Separation performance of double deck banana screens – Part 1: Flow and separation for different accelerations. Minerals Engineering 22 (2009) 1218–1229
[8] https://www.mekaglobal.com/en/blog/vibrating-screen-types