Benefits of high frequency vibrating screen in gold processing plant

HD Ngo[1], TH Nguyen[2], NC Wilsnach[3] and RS Wijekularatne[4]

1.
Technical Director, Mintrex Pty Ltd, Subiaco, Perth, Western Australia 6008. Email: hien.ngo@mintrex.com.au

2.
Senior Mechanical Engineer, Mintrex Pty Ltd, Subiaco, Perth, Western Australia 6008. Email: huy.nguyen@mintrex.com.au

3.
Engineering Operations Manager, Mintrex Pty Ltd, Subiaco, Perth, Western Australia 6008. Email: neil.wilsnach@mintrex.com.au

4.
Graduate Engineer, Mintrex Pty Ltd, Subiaco, Perth, Western Australia 6008. Email: rozaine.wijekularatne@mintrex.com.au

ABSTRACT

Vibrating screens are commonly positioned downstream of the cyclone overflow in order to clean the slurry and remove the trash prior to further gold ore treatment. The common issues associated with the vibrating screens currently available on the market are:

- Poor sealing between the screen moving frame and chute work.
- Blinding of the screen deck which leads to tedious screen cleaning requirements.
- Excessive structural vibration due to the use of low frequency, high amplitude screens.
- Heavy structural steel support to dampen the vibration.

The introduction of high frequency low amplitude vibrating screens such as those offered by Derrick and Sepro has resolved the majority of the issues stated above.

This paper will report on recent case studies where the use of high frequency low amplitude vibrating screens have increased dewatering effectiveness on fine material, eliminated blinding of the screen apertures, increased probability of coarse and fines separation; all contributing to higher screening efficiency. The smaller footprint of these screens has also facilitated better plant layouts in terms of maintenance activities. High frequency low amplitude excitation also means that support structure vibration issues are not as prevalent and light support structures are possible. Typically, these screens are offered as a fully integrated system, which is easy to install and eliminates sealing issues.

INTRODUCTION

Vibrating screens with operating frequencies of between 14 to 24 Hz have a long history of use in gold ore processing. These screens exert harmonic dynamic forces on structures, which can result in unacceptable manifestation of structural vibration if not designed adequately. The use of high frequency (>50Hz) linear screens (HFLS) is gaining traction in the industry not only because of processing advantages, but also advantages in the design of support structures. HFLS are utilized extensively in aggregate, sand, graphite and coal dewatering operations globally. Their design is optimized to handle high volumetric throughput of slurry containing a low percentage of oversize solids (Linear Motion Machines, 2018). This paper demonstrates the capability of using HFLS in gold processing plants.

BENEFITS

High frequency linear screens are multifunction machines; their applications ranging from cyclone overflow trash screening to dewatering and tailings carbon safety. Mintrex has recommended the utilization of these screens in various stages of gold processing as tabulated in Table 1.

Comminution Stage	**Screen Size (m)**	**Capacity (m^3/hr)**	**Screen Area (m^2)**
Carbon Safety	1.2 x 3	730	2.68
Cyclone Overflow Trash	1.2 x 3	790	2.68
Carbon Recovery	0.9 x 2.4	360	1.61
Gravity Scalping	1.2 x 3	790	2.68

TABLE 1 – Use of HFLS in multiple comminution stages.

The HFLS vibratory motors rotate in opposite directions producing a high G-force and exhibit true linear motion. Conventional vibrating screens operate at about 3.5 - 4.5 ‘G’s whereas the high frequency screens are capable of operating at about 7.5 ‘G’s (Kelley, 2006). The high G-force acceleration ensures higher capacity by augmenting fluid conductance rates and the conveyance of screen oversize. Advancing the oversize solids away from the feed flow area is crucial to achieving maximal open area. Extremely low acoustic noise levels are an added benefit in comparison to traditional vibrating screens.

Most vibrating screens used in the industry are supplied without a feed/discharge chute. It is standard practice to allow for a gap between the moving screen and the chute work. Subsequently, spillage and excessive mud accumulation are common occurrences in the surrounding area requiring additional maintenance work. The high frequency screens manufactured by Derrick and Sepro are able to circumvent these issues as the vibrating frame assembly and under pan are incorporated into one watertight design. Furthermore, the prototyping problem is completely avoided with these screens as the design/build/test process for the chute work is taken out of the equation. Merging the chute work in the design of the linear motion machines increases its compactness and ease of installation (Figure 1).

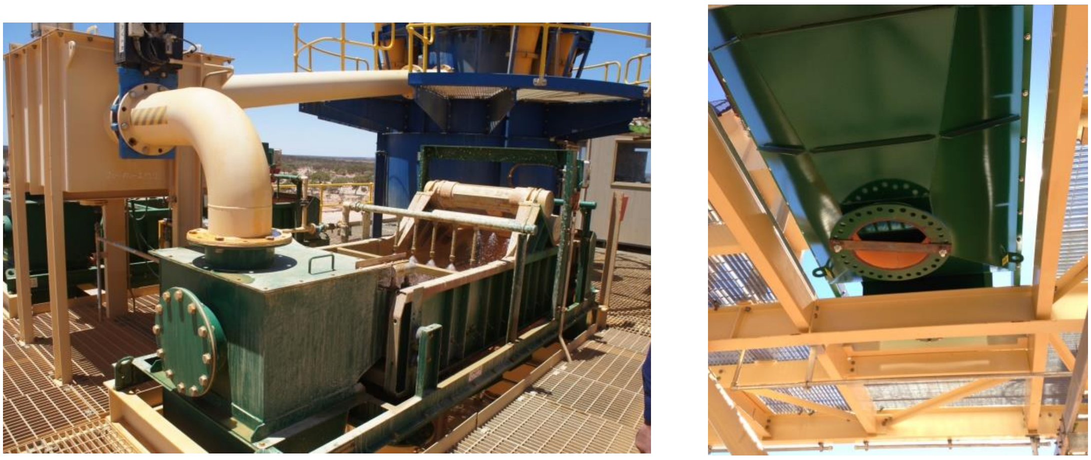

FIG 1 – Fully integrated HFLS system installed at a gold processing plant.

Numerous structural design criteria specify that structures supporting dynamic equipment be “overtuned” meaning the structures’ natural frequency to be greater than forcing frequency) where possible. When the structures’ natural frequency is below the forcing frequency (undertuned), resonance can occur momentarily during start up and for longer periods during shut down or if the machinery is operating below its nominal or peak speed. To design an “overtuned” structure requires an increase in the structural stiffness and this involves bracing and/or heavy structural members to accomplish this.

Mintrex have used both types of screens in the design of various gold processing plants and have recognized the advantages to structural design of support structures using the high frequency linear screens. The case study below highlights some of the advantages.

Case Study – Dual trash screen application

The process design called for two trash screens to be situated above a Carbon in Leach (CIL) circuit. This involved supporting the screens on the “top of tank” steelwork at a higher level. There was limited opportunity to have an isolated structure to support the vibrating screens.

Two 3.66x7.32 m screens operating at 16.25 Hz were considered for this duty. Natural frequency and harmonic response analysis was conducted. (Tedesco, et al. 1999) The results indicated that predicted vibration response was in excess of industry-accepted limits and that the support structure as well as the supporting CIL tank was required to be stiffened significantly.

The analysis was re-run using two HFLS that could accommodate the same throughput as the conventional screens. The results of the analysis indicated that the support steelwork could be arranged such that it would result in a smaller footprint as well as a 4.7 t reduction in mass of the structure to 4.2 t compared with the initial 8.9 t as illustrated in Figure 2.

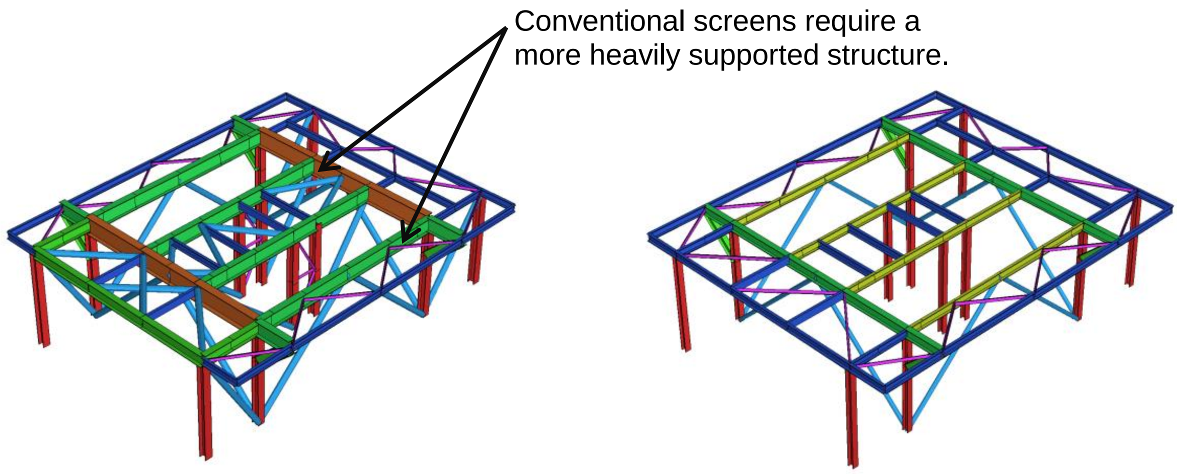

FIG 2 – Comparison between support structures for conventional screens and high frequency screens.

The smaller footprint of the HFLS enables the development of a simpler plant layout as well. Conventional trash screens occupy a larger area than high frequency screens that are capable of handling a similar duty as illustrated in Figure 3.

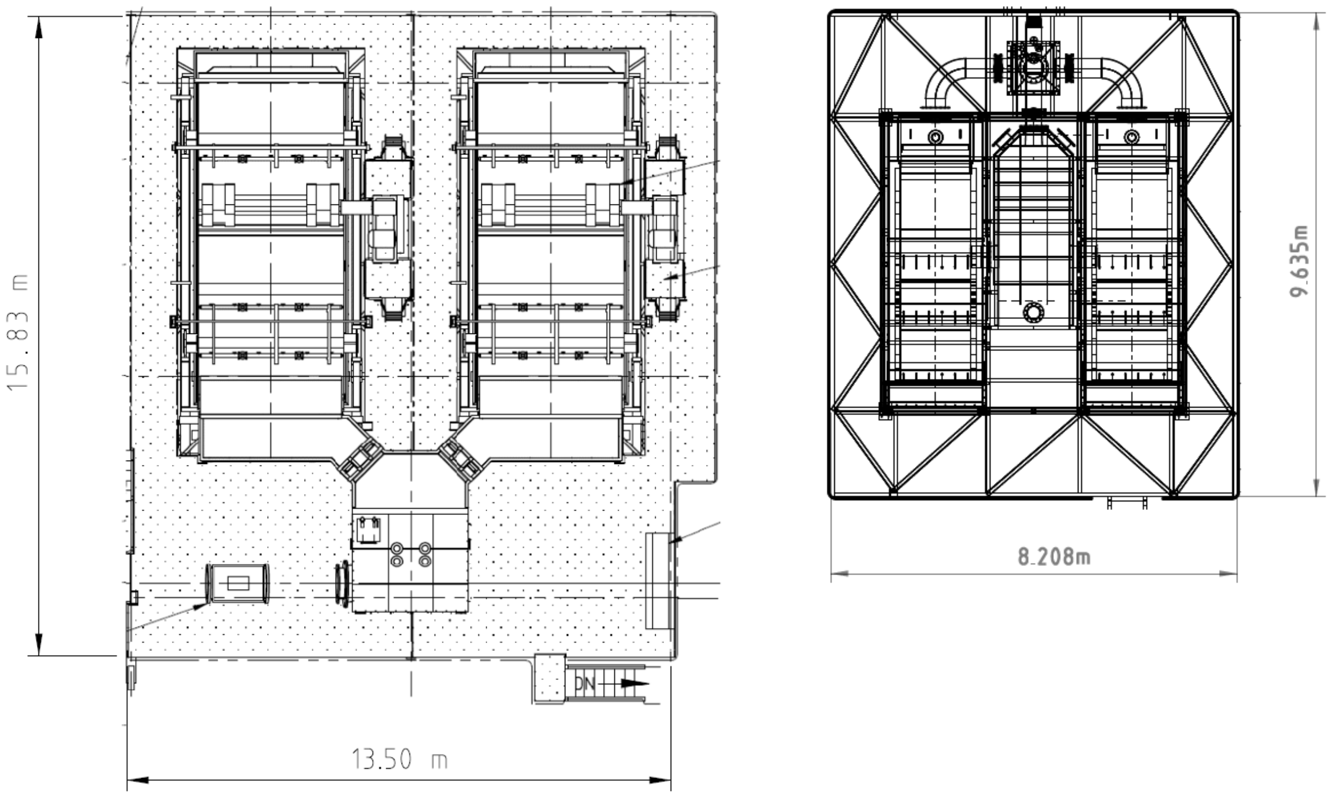

FIG 3 – Size comparison between conventional cyclone overflow trash screens - left (Lycopodium 2011) and HFLS - right.

An initial cost comparison had revealed high frequency screens to be a more expensive option. Substantial savings in structural steel (See Figure 2 and Figure 3) and piping (material, drafting, design check), however, reduced the overall expense of incorporating these fully integrated systems into the plant design. Furthermore, the cost of the launders is included in the total price for HFLS resulting in a higher value for price.

Table 2 presents a comparison between the traditional screens described in the case study and the HFLS with similar throughput processing capacity. Despite the smaller size of high frequency screens, they are capable of achieving high circuit capacities and efficient fine particle separation. HFLS demonstrate an increased performance rate with a drastic reduction in overall energy consumption.

	High Frequency Screen	**Conventional Screen**
Nominal screen size	1.52 m x 4.27 m	3.66 m x 7.32 m
Screen area	6.5 m^2	26.8 m^2
Screen open area	2.6 m^2	3.2 m^2
Screen open percentage	40%	12%
Flow rate	1590 m^3/hr	1533 m^3/hr
Power	7.44 kW	45 kW

TABLE 2 – Size and performance comparison between high frequency and traditional vibrating screens.

Media blinding is another common issue virtually eliminated by the use of HFLS. Blinding affects screen feed rate, which in turn, could result in conveyance of undersize particles and fluid to the oversize stream (Albuquerque, et al. 2008). While the design of the high frequency screen frame allows the use of traditional wire panels, urethane panels are more favourable as their flexibility coupled with the high frequency vibrations heavily diminish media blinding. During stratification, a higher tendency exists for near-size particles to filter through the screen due to its flexible nature reducing screen blinding. Minimal blinding correlates to a greater flow rate, and reduced screen cleaning. Figure 4 is illustrative of typical trash screen blinding which minimizes flow rate.

FIG 4 – Blinding of conventional screens greatly reduces screen open area resulting in lower screening capacities.

Prevalent screen cleaning techniques involve blasting the screen with high-pressure water. The fragile nature of these screens prevents cleansing via the aforementioned method, as it would result in major damage and replacement. A lesson learned – It is critical to ensure that the design of the water outlet for screen cleaning includes a pressure control valve.

CONCLUSIONS

In summary, the advantages of using high frequency linear screens are:

- Smaller support structure footprint – the overall size of the screens are less than that of conventional screens for the same duty.
- The HFLS feed and discharge chutes integrated with the screen results in reduced support member requirements when compared with conventional screen arrangements. Conventional screens require bespoke feed and discharge chutes, and associated support steelwork. Consequently, common issues such as the prototyping problem and poor sealing between the vibrating frame and the chute work can be avoided by using HFLS screens, and as a result, spillage and clean up concerns are minimized.
- Static loads for HFLS are less that of conventional screens for similar throughput duties.
- Minimal screen blinding- the flexible nature of the panels does not promote blinding of the screen apertures.
- Achieve greater capacity by higher ‘G’ force acceleration and increased screen open area.
- Reduced steel mass required to support HFLS - Due to minimal dynamic loads being transferred to the support structure, the structural arrangement can be reduced.
- Reduced overall cost – Due to less structural steel and piping requirements along with inclusive launder cost. Operating costs are also reduced due to lower power consumption.

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