STM-SCREEN™ Technical Study

High-Volume SAG, AG, HPGR Comminution Circuit Screening

Mine size and tonnage have grown exponentially over the recent decade. Material handling/processing equipment also increased in size resulting in 400 MT haul trucks, 2000 KW crushers, 12 M SAG/AG mills, 8.5 M ball mills, 3000 M3 flotation cells, and 12.5 MW HPGR's became standards in the global mining industry. Further process capacity is expected to continue growing.

Other critical equipment, including vibrating screens, has had to increase in size to handle tonnages and feed rates upwards of 3500 MTPH. Currently, there are circuits under design that will require screening feed rates of 4500 MTPH.

Large "Brute Force" Banana and Horizontal Screens are the industry standard for SAG, AG, Crusher, and HPGR comminution circuits. However, as the size of these screens expanded to address increasing comminution circuit capacities, inherent limitations to their design and construction became evident. The flaws in the screen design manifested in poorer screening efficiency, diminished screening energy, reduced mechanical reliability, and combinations thereof.

It is not uncommon for high-volume, high-value comminution circuits to operate significantly below their design tonnages due to under-performing Brute Force vibrating screens. General Kinematics' Proprietary STM-SCREEN™ operates beyond the finite design limitations of large Brute Force screens. The STM-SCREEN™ is designed and constructed to process higher tonnages, at circuit design efficiencies. While the industry has accepted screens lasting less than 18 months, the STM-SCREEN™ is reliable and designed for operations years beyond this threshold.

General Kinematics STM-SCREEN™ is the solution mines are seeking to maximize comminution circuit production tonnages, both Wet & Dry.

Low Cost of Ownership Highest Possible ROI:

- Extend deck panel service life by up to 50%. The material does not slide across the deck panels but is propelled up and down along the entire length of the screening surface of the screen.
- Screen life of 5+ years vs. >2 years for conventional brute force machines. The STM-SCREEN™ is more ruggedly constructed since vibratory drive forces are evenly spread around the structure. The STM-SCREEN™ is never subjected to torsional forces and machine frequency stresses like that of conventional screens.
- Increased revenue. The STM-SCREEN™ can process higher tonnages, with higher efficiency to maximize the run of mine throughput and minimize the recirculating load.
- Higher reliability and uptime. Reduce the likelihood of unscheduled outages and loss of operating revenue.

Longer Service Life:

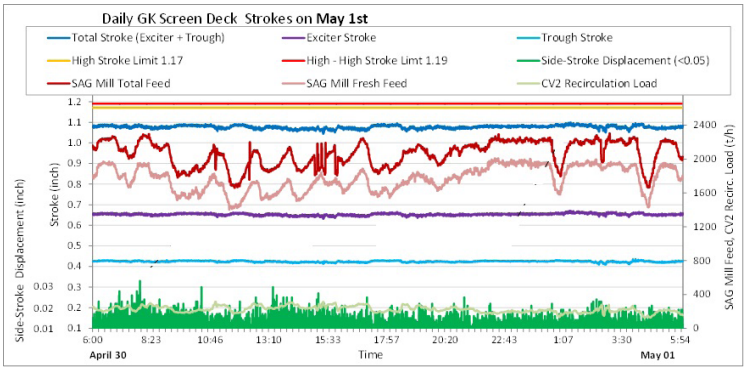
The rugged design of the STM-SCREEN™ and it's unique features combined with proprietary drive technology can extend service life to greater than 5 years.

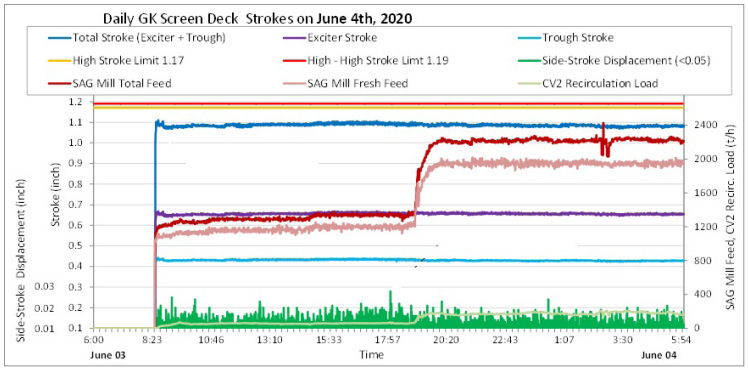
- Two-Mass vibrating screens 2.4M and wider are designed with a center plate extending the length of the machine. Multiple cross beams and K braces extend from the center plate to the side panels, creating a structure free of any torsional stresses. It is torsional stresses that are constantly applied to conventional screens which lead to screen failure. The center plate allows for a more compact machine. A double-deck Two-Mass vibrating screen has less height than a typical single deck Brute Force screen allowing the opportunity to replace the single deck Brute Force screen and greatly increase capacity. The entire throughput of the process stream improves by increasing the screening capacity within the same footprint.
- The STM-SCREEN™ has multiple spring brackets (drive beams), compared to one drive beam on conventional brute force screens, that connect the side panels to the center plate. This has a couple of key benefits. First, the beam length is reduced by half, which reduces beam deflection forces by a factor of four. Second, having multiple spring brackets evenly spreads vibratory drive forces throughout the entire structure. This prevents the side panel degradation commonly found in brute force units.
- The Two-Mass vibrating screen's deck panel support frames have bolted on sections that can be easily replaced when localized wear occurs, during routinely scheduled outages.

Lower stress, longer life. The STM-SCREEN™ utilizes GK's proprietary Two-Mass low-stress vibratory drive technology that features an exciter mass with eccentric vibratory motors connected to the screen trough mass by a network of coiled springs.

- The spring network amplifies the force from the exciter to the screen mass, so the required HP is 3 to 4 times less than a conventional screen as they are directly attached to the screen mass.
- Two-Mass vibrating screens operate sub resonant to the machine's natural frequency with low eccentric force vibratory motors. The STM-SCREEN™ goes from idle, through sub frequencies to full operation, and back to idle very smoothly. It does so without sending significant dynamic forces into the support structure or causing stresses to the machine structure itself. Conversely, conventional screens require very large eccentric forces and operate past the natural frequency of the screen structure. Large eccentric forces tend to linger on the frequencies as the screens go from idle to full operation and back to idle. This subjects the screen to severe stresses and results in high dynamic forces impacting the screen's support structure.
- The STM-SERIES® designs are customizable.
  - Special attention can be focused on high material impact areas to protect loading zone surfaces from wear and damage.
  - Wetted surfaces in the lower structures can be lined with rubber to withstand abrasive slurry streams.
  - For corrosive conditions, there is a wide array of coating options and choice of steel alloys to select from to best address specific objectives and process conditions.

Higher Capacity, Higher Efficiency:





In the graphs above, the Red Line is the "SAG Mill Total Feed", the Light Blue Line is the "Screen Deck Stroke", the Light Green Line is the "Recirculation Load". Notice in the left slide above, the Screen Deck Stroke (Light Blue Line) remains constant while the SAG Mill Total Feed (Red Line) to the STM Screen greatly varies. Notice in the right slide above, the Screen Deck Stroke (Light Blue Line) remains constant as the SAG Mill Total Feed (Red Line) to the STM Screen nearly doubles approaching circuit design capacity. The right slide also shows the Recirculation Load (Light Green Line) proportionally increases with the SAG Mill Total Feed (Red Line) indicating that screening efficiency is constant as SAG Mill Total Feed nearly doubles

- A STM-SCREEN™ can replace a Brute Force screen and provide up to a 40% Increase in circuit capacity.
- Two-Mass vibrating screens are modifiable to accommodate higher tonnages and deeper material bed depths.
  - Masses can be made heavier; motor HP increased, and more springs added to the spring network to ensure that material is consistently stratified along the length of the screening surface at the constant design stroke amplitude.
    - Machine stroke is maintained under full load to sustain designed material stratification and screen efficiency. Whereas the stroke of Brute Force screens is dampened as the material load is increased and screening efficiency is negatively affected.
- The STM-SCREEN™ typically retains material 3-4 times that of Brute Force screens in order to achieve higher screening efficiency. Brute Force screens accelerate material to thin the bed depth, limit material weight on the screen, and retain the material for only 8-12 seconds.
  - For wet screening applications, the STM-SCREEN™ has significant de-watering advantages. Typically, the water spray is limited to the first 2/3rds of the screen length leaving just the final 1/3rd for de-watering. With greater material retention time on the STM-SCREEN™, there is a corresponding increase in de-watering, allowing more excess water to be removed.

The STM-SCREEN™ can replace a Brute Force screen and provide up to a 40% increase in circuit capacity. The STM-SCREEN™ is designed to fit within the existing space and rest on the existing screen footings, without overhauling existing support structures. The STM-SCREEN™ should not require modifications to the existing structure because sub resonant, Two-Mass vibrating screens have far lower dynamic forces than equivalent size Brute Force screens. The service life of the STM-SCREEN™ exceeds industry standards by years. In summary, the STM-SCREEN™ has greater longevity, fits seamlessly into the existing footprint and can substantially increase circuit capacity.

Size Range

- Standard single deck and double deck machine sizes range from 1.4m wide to 5.4m wide to 10m long. All can be modified to mount on an existing screen footings.
- Purpose-built machines can be of any size required to replace an existing machine and feature hybrid decks and triple deck configurations.
- The large model STM-Screen™, >2.4M wide can be designed in a modular fashion so it can be dismantled in sections after test runs in the factory, shipped to distant locations and then reassembled at the mine site.

Other Applications

- High volume mineral sand screening
- Drain & rinse coal beneficiation & magnetite recovery screening
- Petroleum coke de-watering screening
- Product de-watering screening
- Carbon recovery screening