Generation Next

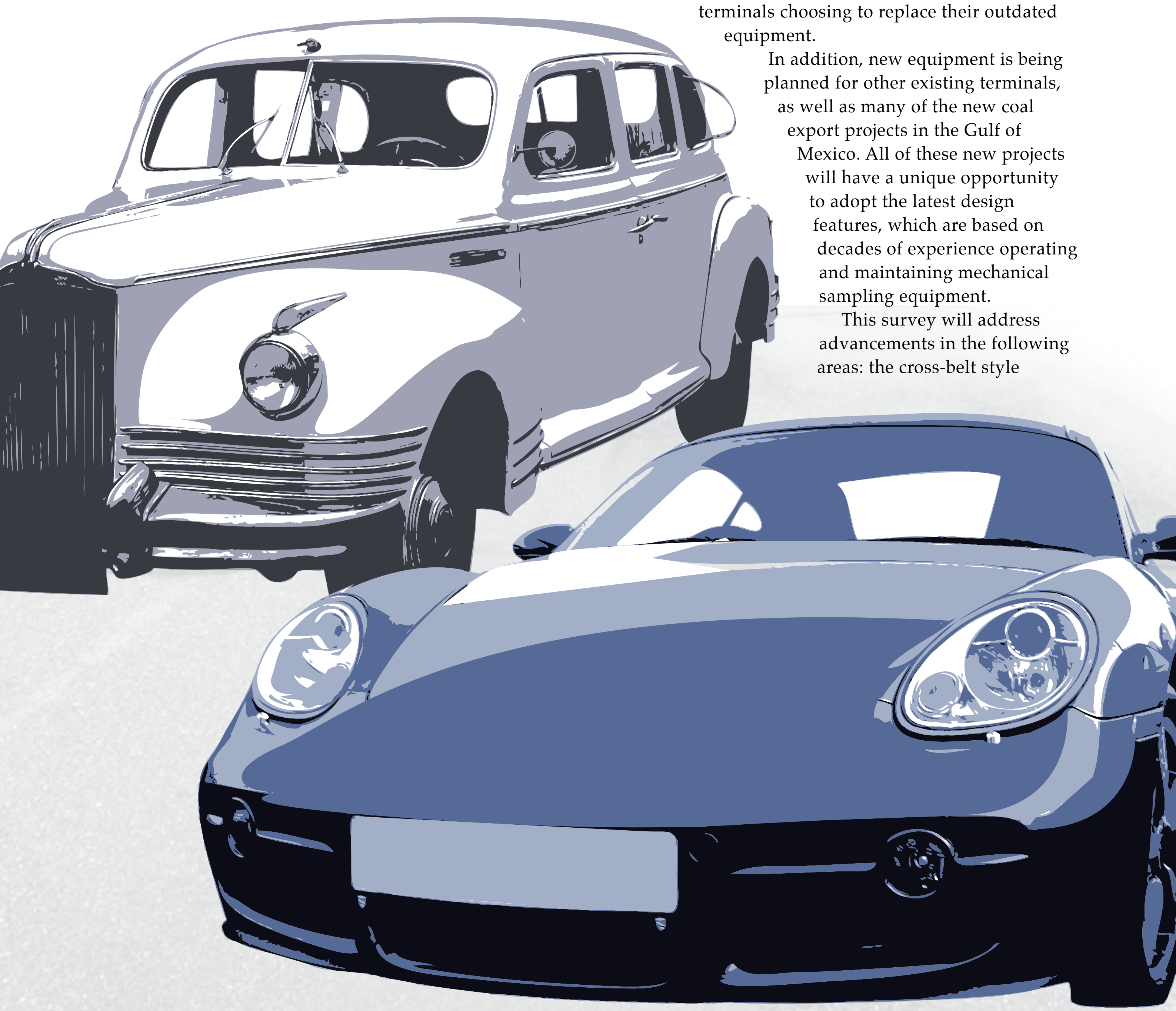
Paul Reagan, Sampling Associates International, US, surveys new developments in sampling systems.[1]

The seaborne trade of coal has risen dramatically in recent years to over 800 million tpa, virtually all of which will be mechanically sampled during the loading of vessels. This article will survey the latest advances in the field of mechanical sampling in both equipment design and the application of technology to enhance system performance.

In the last several years, there has been a plethora of new sampling system installations in the US, due primarily to the long-established terminals choosing to replace their outdated equipment.

In addition, new equipment is being planned for other existing terminals, as well as many of the new coal export projects in the Gulf of Mexico. All of these new projects will have a unique opportunity to adopt the latest design features, which are based on decades of experience operating and maintaining mechanical sampling equipment.

This survey will address advancements in the following areas: the cross-belt style



primary sampler and its increment collection; damage prevention; sampling for size analysis; improved operations and maintenance access; material flow; and electronic monitoring and record keeping. The designers of these next generation sampling systems consulted with the operation and maintenance personnel most familiar with the strengths and weaknesses of existing equipment. The result of this collaboration is a much improved, user-friendly, effective and robust sampling system.

The cross-belt sampler

The primary cross-belt sampler component of a mechanical sampling system is one where the primary increment is collected directly from a terminal's conveyor belt as it is in motion. This design eliminates the need to fit new equipment into a terminal's transfer point. Sampling systems designed to collect within transfer points are known as cross-stream systems. While some are still sceptical regarding the ability of the cross-belt design to collect good primary increments, the vast majority of new sampling plants are of the cross-belt type.

There are a number of design features regarding the cross-belt primary sampler that should both reassure the remaining critics and be considered for any new installation.

One essential feature is an idler arrangement that forms the main conveyor belt into an arc beneath the area where the primary sampler collects the increments. This arc must match the radial sweep of the primary sampler, while providing support to the belting directly under the point of sample collection. This allows for the best possible full cross-stream increment delimitation. Figure 1 is an example of such an arrangement.

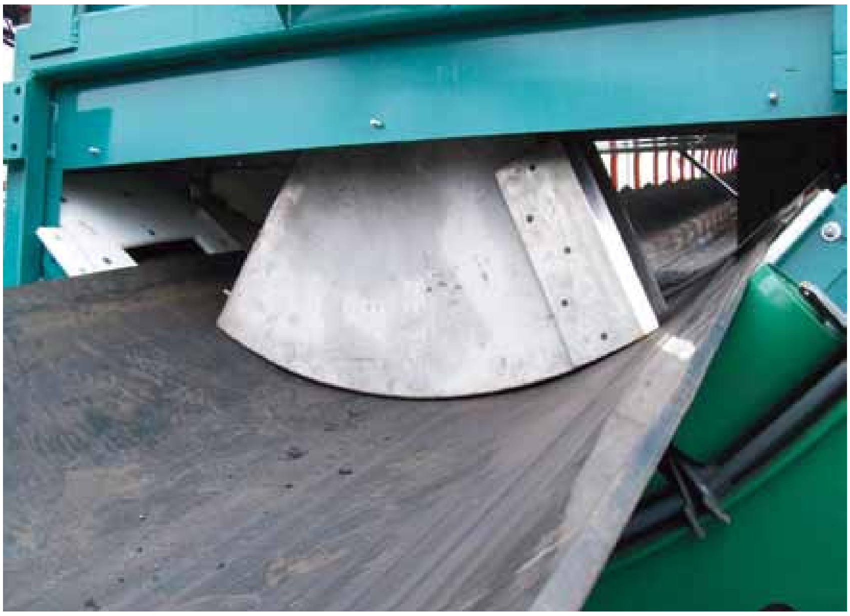


Figure 1. Contour arc with impact and shaping idlers.

A second feature of the primary sampler is bevelled and removable cutter "lips" (Figure 2). The bevelling achieves better increment delimitation and the removable cutter lips allow for the periodic replacement of damaged or worn lips without having to rebuild the entire cutter.

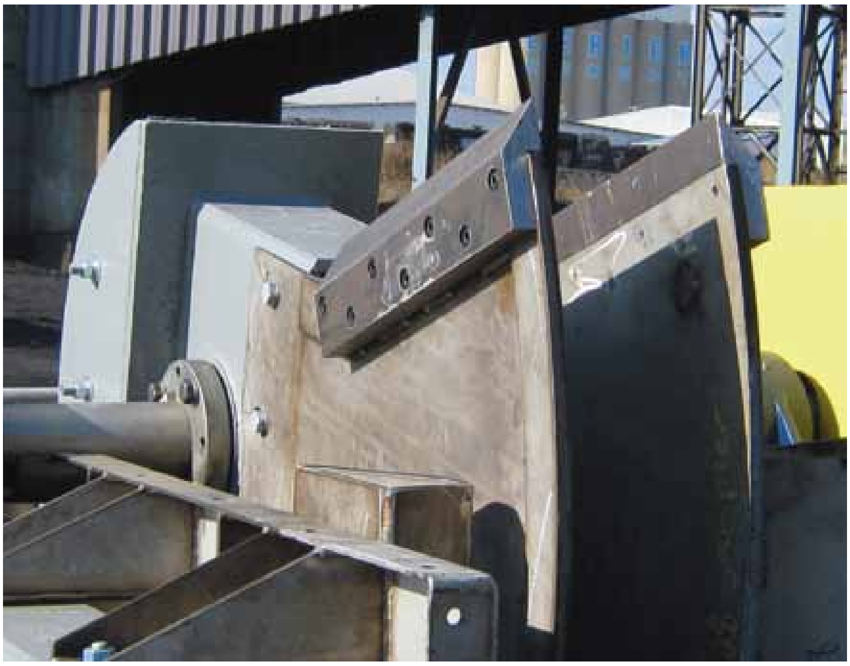


Figure 2. Bevelled and replaceable cutter lips.

Thirdly, most primary samplers have been mounted with their drive train parallel to the conveyor belt from which the sample increment is extracted. When the conveyor belt is on an incline, the drive train is then installed at the same angle. This not only causes oil levels in the gearbox to be off-centre, but it makes the drive train very difficult to maintain. Maintenance work, especially drive realignment, is made unnecessarily difficult due to the effect of gravity on the heavy components.

In some recent installations, these problems have been effectively eliminated by mounting the primary sampler drive train level (parallel to grade as long as the grade is flat). This approach, however, requires modifying the cutter profile to compensate for the belt incline. This design has performed well and has been bias tested with successful results.

A final feature of the new primary sampler design worth mentioning is robust skirting around the opening where the cutter deposits the primary sample increment into the next stage of the sampling system. When the primary sampler sweeps the sample increment off the conveyor, there is a momentary material buildup on the sides of the sampler that is swept in the direction of the receiving hopper. This skirting prevents non-sample coal from entering the sampling system and contaminating the collected sample (Figure 3).

Damage prevention

In the sampling system shown in Figure 3, a series of bars – sometimes known as a "grid" or "grizzly" – have been installed in the discharge area of the primary sample cutter. This prevents debris or over-size material from entering the down-line components of the sampling system. Over the years, this feature has proven invaluable in preventing downtime caused by equipment damage and plugging within the system.

Another important protective feature that can be added to the system is to place a metal detector on the main conveyor, up-stream of the sampling system. Each time metal is detected, a signal is sent to the sampling system programme to "pause" the cutter from operating until the threat has passed. This prevents metal objects from entering and potentially damaging the sampling system. Magnets are also helpful, but they do not always capture all the metal and are not effective against non-ferrous metals.

Mechanical size sampler

As many seaborne coal transactions require a test for size consist of a consignment, an important feature of new sampling plant installations is equipment for the mechanical collection of this sample. This is simply a smaller scale stand-alone cross-belt style cutter that randomly sub-samples the uncrushed primary increment before it is fed into the crusher (Figure 4). This feature does require inclusion of a primary feed conveyor to move material from the receiving hopper to the crusher.

Maintenance access

The most welcome design features in new sampling systems are those that improve the daily life of the system operators and mechanics. One of the best examples relates to the key component of any sampling

Figure 3. Primary receiving hopper with debris bars.

Figure 4. Mechanical sampler for sizing.

system, the crusher. The crusher reduces the collected coal sample to the recommended size for further division into the desired laboratory mass. The crusher demands frequent attention and regular maintenance. As such, ease of access to work on this component is a must. There are a number of very good models available that provide quick and good access. These improved crushers are not new, but warrant a mention in this review.

Many modern cross-belt sampling systems utilise a shipping container to house the sample processing equipment. These containers are ideal as they are durable, allow for standardised designs and are easily transported and installed. One advance in design is to place the crusher on top of the container, rather than inside. In sampling systems where the crusher is located inside the container, ordinary cleaning and maintenance can be difficult and time consuming. This novel arrangement allows for adequate working room around the crusher for operations and maintenance personnel. In addition to placing the crusher on the top of the container, many of the new systems have enclosed the crusher area in a "room" (Figure 5). This protects the crusher from the weather and is more environmentally-friendly.

Other recommended features for maintenance access are not new – but sometimes are not included unless specifically requested of the manufacturer. One necessity is safe and easy access to maintain and clean sampling system components. Figure 6 shows a reject conveyor, which returns non-sample material to the main conveyor, that incorporates several of the features ideally seen in new installations.

First, note the extra wide walkway for operations personnel. Secondly, on the top of the conveyor housing, multiple access doors with easy access locking mechanisms (red handles) can be seen. The same type of locking devices on doors on the underside of the conveyor can also be seen. Finally, note the panels on the side of conveyor housing. These are access points for each of the conveyor's idler racks. This allows for the easy servicing or replacement of worn idlers without having to dismantle the housing itself.

One desirable feature that has been available but seldom used in sampling systems is self-aligning conveyor idlers. This removes a frequent maintenance headache as they can prevent material spillage and eliminate damage to the conveyor belting caused by misalignment.

Material flow

No review of mechanical sampling systems can be complete without a word on material flow. Wet coal, cold weather and steel are natural enemies and coal will stick everywhere that it impacts metal. This phenomenon is exacerbated by the large mass of coal passing through the sampling system at the higher load rate terminals. A large percentage of US coal exports are finely sized metallurgical coals, which retain moisture due to their increased surface area. Such material presents handling issues that can result in significant system downtime.

One essential technology application is the pairing of a vibrator with a plugged chute indicator at all transfer points and especially before and after the


Figure 5. Crusher mounted on top of container.

crusher (Figure 7). The vibrator can be programmed through the sampling system's programmable logic controller (PLC) to activate both on a prescribed frequency of operation and whenever the corresponding indicator is activated due to material buildup or a blockage.

It is important to keep in mind that there are multiple types of chute indicators. A reliable type of indicator for this type of application is one that uses split architecture. Split architecture reduces premature failure by locating the electronic components of the chute indicator, which are susceptible to damage, away from the source of vibration.

Figure 6. Conveyor with excellent maintenance access.

Also important for maintaining material flow is good access doors to facilitate inspection and cleaning at key points throughout the sampling system. Best practice incorporates frequent cleaning to remove buildup, prevent corrosion and to assure mechanical sampling of the full consignment.

Another key enhancement is the widespread use of stainless steel. The extra cost can be well worth the added benefit of improved material flow characteristics and long-term corrosion protection. In the company's experience, stainless steel is essential to extending the useful life of a sampling system. It is also cheaper to implement in the initial fabrication of the system rather than replace multiple components as they corrode prematurely.

A well-maintained sampling system with stainless steel in all key areas should last 20 – 30 years.

Electronic record keeping

The last technology feature in this survey is using the power of a PLC to enhance the operation of the sampling equipment. All modern sampling systems come with a human machine interface (HMI) display panel connected to the PLC, so that the operator can monitor the equipment, and rapidly troubleshoot many problems or failures.

The PLC and its integration with an HMI can also be used to record a history of the sampling system and its components. A record of all of the start and stop times, the frequencies and activations of the cutters, the emergency stops and electrical disconnects, the fault alarms, etc. can greatly enhance the research of equipment problems or the determination of cause when test results are not as expected.

Finally, all of this recorded information can be transmitted using the internet so that others can participate in the monitoring and troubleshooting. Some locations are even installing cameras and recorders so that key locations can be monitored and attendance verified.

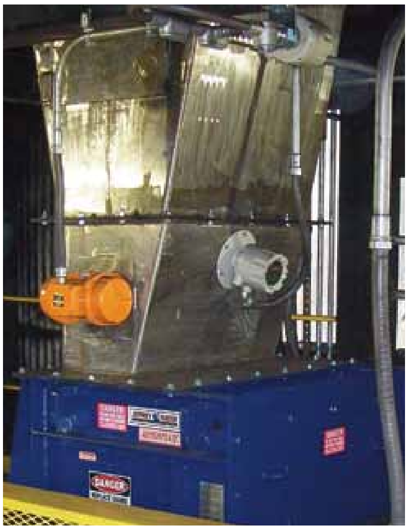


Figure 7. Plugged chute indicator with vibrator.

Conclusion

The operation of sampling equipment at the export terminals in the US is attended 24/7. Much of the original systems were not designed with the operations and maintenance personnel in mind. Fortunately, that has begun to change. This next generation of sampling systems is effective, robust and combines the manufacturer's innovation with the operator's experience. The features listed above represent some of the best ideas from that joint effort. The result is a generation of systems that sample accurately, handle a wide variety of coals, remain online at very high percentages, are user-friendly and will last longer than their predecessors. WC

Note

This article is a follow-up to a previous article published in *World Coal* in April 1999.