02/2022

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MINERAL PROCESSING WORLDWIDE

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merz:

Mills and Crushers

from the Black Forest since 1919

© NVV Gypsum

Trends & Equipment

Gypsum – a scarce raw material 29

Screening

Advantages and areas of application, comparative screening tests 42

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THE FUTURE - TRACKED MOBILE IMPACT CRUSHER

GIPOREC

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- Air classifier
- Crusher direct drive

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Ulrike Mehl
Editor AT MINERAL PROCESING

Innovative concepts

Dear readers

The discussions about the future energy supply are accompanied, e.g., by the question of the future availability of the raw material gypsum, which is used both as a natural raw material and in the form of synthetically produced raw material – gypsum from flue gas desulfurization plants (FGD gypsum) as a byproduct of coal-fired power generation – in many areas of everyday life.

Starting on p. 29, Dr. Joachim Harder gives an overview of how the global demand for gypsum will change in the coming years and what role the production of natural or synthetic gypsum, the processing of phosphogypsum and also gypsum recycling will play in meeting this demand.

thyssenkrupp reports on the optimization of the CK+ circular motion vibrating screens, which are also equipped with the innovative drive concept of the newly developed goovi® multiple vibrating screen – starting on p. 38. With a more compact design, a significant reduction in the number of rotating parts, and lower installation and maintenance requirements, the new CK+ screening machines simultaneously enable very high throughput rates with excellent separation sharpness.

Innovative screening technology is also the focus of a technical article from Binder+Co concerning the new BIVITEC e+ type series, from p. 42. The advantages and fields of application of the new type series are explained on the basis of several case studies against the background of comparative screening tests, including the presentation of the test results.

A technical article by Martin Engineering, starting on p. 52, deals with so-called conveyor rules of thumb, which should be observed, e.g., for the manufacture of a safe and productive conveyor system.

In addition, you will find other interesting articles as well as a report concerning the newly developed PYC 130-A pycnometer from Siebtechnik GmbH (pp. 24) and announcements about events in the sections FOLLOW UPS (p. 7) and FOCUS INDUSTRY (from p. 8).

Wishing you enjoyable reading

Ulrike Mehl

© REMA TIP TOP ME

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© thyssenkrupp Industrial Solutions AG

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COMPANY NEWS

Optimized lifetime of wear parts

Mining customers will benefit from the closer cooperation of thyssenkrupp Mining Technologies and Magotteaux by optimized and cost-efficient wear parts for mining and aggregates equipment. The long-standing partnership will now be extended into the development of innovative wear parts with Metal Matrix Composite (MMC) technology. The cooperation agreement strengthens future joint research and development efforts, through shorter development times and a customer- and market-focused research & development effort – enabling even faster introduction of high-quality wear parts with higher profitability for mining customers.

Magotteaux has extensive expertise in MMC Technology for wear-resistant castings offering a longer service life and a better cost/benefit ratio. This technological lead is based on numerous patents held by the company in this area. The alliance of thyssenkrupp's process expertise and Magotteaux's manufacturing expertise will offer customers worldwide cost effective wear parts of equipment by combining their respective knowhow and IP to offer valuable and unprecedented solutions. It clearly pays off and has already achieved visible results for various customers. For example, in the development of concaves for gyratory crushers, which were developed and introduced in 2021, currently showing proof that the wear behavior is much better compared with standard wear parts, even under the toughest conditions. thyssenkrupp Mining Technologies has also secured further competencies in MMC technology with an exclusive license agreement with Innerco Sp. z o.o..

© thyssenkrupp Mining Technologies

thyssenkrupp and Magotteaux extend strategic partnership

www.thyssenkrupp-industrial-solutions.com
www.magotteaux.com
www.innerco.pl

Weir Minerals and AVEVA sign agreement

Weir Minerals and AVEVA have signed a digital business framework for strategic cooperation. The objectives of the agreement include:

- Digitally enabling the mining industry by simplifying data access and data sharing with easy and secure on-premises or cloud integration between Weir Minerals and its customers.
- Establishing the data foundation for technologies, such as artificial intelligence, to optimise equipment and processes and thereby maximising sustainable performance.
- Pioneering new and innovative digital solutions supporting customers digital transformation and adoption of intelligent solutions.

© Weir / Aveva

Synertrex® Monitoring Centre in South Africa

Weir Minerals will utilise the AVEVA PI System™ to collect, contextualise and analyse data streams, which will become the data foundation of its Synertrex® digital ecosystem. This – along with AVEVA Data Hub, a cloud-native hub for aggregating and contextualising on-premises and remote data – will offer the mining industry a unique solution for securely connecting mining operators with Weir Minerals as an OEM.
The business model will provide a variety of flexible integration solutions that will make it easier for miners to integrate with the Weir Minerals' Synertrex® digital ecosystem. It uses a secure and simplified approach to access and share real-time and historical operations data.
These shared ecosystems will provide miners and Weir Minerals with full data transparency and an easy-to-access, real-time 360-degree view of all Synertrex®-enabled equipment and processes. They will also be the basis of the further development of digital twins and predictive algorithms, which will provide decision-makers with recommended actions and real-time decision support.

www.global.weir
www.aveva.com

COMPANY ORDERS

FLSmidth order for Josemaria copper mine in Argentina

FLSmidth has been chosen to supply the SAG mills, ball mills and cyclones to Josemaria Resources' copper-gold project in the San Juan Province of Argentina. FLSmidth will deliver the three gearless SAG mills, three gearless ball mills and cyclones to the 150 000 t/d site by late-2023. FLSmidth was chosen to deliver the equipment due to the high reliability and efficient performance of our SAG and ball mill technologies.

The Josemaria open-pit mine is a high-grade copper-gold porphyry project. It is located in Argentina some 450 km from San Juan, capital city of the province, in an important and emerging copper mining district. It has an anticipated mine life of 19 years. "The order of SAG mills, ball mills and cyclones to the Josemaria Resources copper-gold project in Argentina is very positive news for FLSmidth. It illustrates great confidence in FLSmidth and emphasises the proven performance and productivity of our high-end solutions. The efficiency of the equipment will meet our customer promise to deliver sustainable productivity to the copper and gold mining industry," comments Mikko Keto, Group CEO and Mining President at FLSmidth.

www.flsmidth.com

PRODUCT NEWS

Eirich Group acquires stake in start-up

Eirich is setting a new milestone. A joint venture with the name "Prosio Vision" offers intelligent control technology for the bulk material industry and will serve as the AI center of the Eirich Group. Under the Qualimaster name, Eirich has been offering in-line process monitoring for supplied systems and operations across many industries and processes for decades already. Working together with Nuremberg start-up Prosio Engineering, Eirich has now developed a new camera-based system, the "Qualimaster VC1", for the optical quality assessment of granules. The new measuring system combines cutting-edge camera technology with AI-based intelligent analysis software. This allows key variables of granular materials, such as particle size distribution, grain shape and grain surface, to be measured. The data obtained open up many different possibilities in the control of complex production systems for the optimization of product quality and line efficiency.

www.eirich.de

© Eirich

Qualimaster VC1

Metso Outotec expands the Nordtrack range

© Metso Outotec

Metso Outotec adds a new impact crusher to its Nordtrack mobile crushing and screening range, targeting especially smaller-sized applications and jobsites in the construction and demolition waste recycling segment. The Nordtrack™ I1011 mobile impactor has compact dimensions and a powerful, high-performance crusher, ideally suited for contractors and rental work. Equipped with a large hanging screen, it combines high crushing capacity with calibrated end product accuracy.

The versatile Nordtrack I1011 crusher is suitable for working in different jobsites from rock crushing to concrete and demolition waste recycling. It is transported on a standard trailer, making it cost-effective and quick to move between sites. Thanks to its agility, moving the equipment in tight places inside the jobsites is easy. With Metso Outotec's service support and global inventory of parts like different blow bar options, Nordtrack I1011 is a dependable choice for contractors and as a rental machine. "The I1011 has a more powerful crusher and engine, resulting in a capacity as high as 300 t/h. As a mobile crusher it also is well suited for the recycling of demolition and concrete waste, or reclaimed asphalt," says Vesa Tuloisela, who heads the Nordtrack product offering at Metso Outotec.

www.mogroup.com

Universal transmitter makes sensors "wireless-network-compatible"

Wireless network integration opens up new application fields for switches and sensors – for example optimisation of in-house material flow using eKanban systems. A prerequisite is that all components are suitable for radio transmission. However, this does not necessarily mean an integrated radio module: a separate external universal transmitter does the job just as well. The new products of steute Technologies include an I/O unit permitting existing mechanical switches and e.g. non-contact sensors to be integrated in an sWave.NET wireless system. The new RF I/O-NET wireless universal transmitter facilitates the wireless transmission of signals from switches and sensors which are actually cabled. For users of wireless networks, the range of network-compatible products has therefore widened. This has advantages not only when planning new wireless systems, but also when retrofitting existing plants with wireless networks. The "little" RF 96 ST-NET wireless universal transmitter for one switch or sensor will remain in our product range. Like all nexy components, the devices can be programmed remotely and conveniently via the user interface of the wireless system.

www.steute.com

© steute

Universal transmitter RF I/O

New date

18th Conference Belt Conveyors and their Elements postponed to 08 to 09 June 2022

Overland conveyor – Middle East desert

© REMA TIP TOP ME

The 18th Conference Belt Conveyors and their Elements at Haus der Technik, Essen/Germany has been postponed to 08 to 09 June, 2022. The annually belt conveyor forum offers 14 new lectures live: the Key-note Supply Chains for Battery Minerals and 13 more lectures by renowned experts from RWE Technology international, Siemens AG, Voith SE & Co, Beumer Maschinenfabrik, TAKRAF GmbH, LHB mining solutions, REMA TIP TOP AG und REMA TIP TOP Middle East, Schade Lagertechnik, ContiTech Transportsysteme, Hosch Fördertechnik und DMT.

Topics of day 1: CO_2-reduction for international mining projects, Simulation as key for fast and safe installation, iron ore terminal, ship loader, and inspection and maintenance work for ship loaders and unloaders, CEMA drive drum strength requirements and steep incline conveying. Topics of day 2: putting a scraper-extractor into operation, the most common damage cases and processing of claims for belt conveyors, improving reliability and monitoring of belt conveyor projects, digital services for belt conveyors, special services for conveyor belt cleaning systems, explosive dusts from different sources used in alternative fuels.

The conference is scheduled as a Live-Event – the option to participate online is given – combined with an exhibition of belt conveyor products and services, an evening event on day one and a technical excursion to Mining Museum Bochum.

www.hdt.de/gurtfoerderer2022

The new Trio® TC84XR live-shaft cone crusher

High performance in crushed ore and quarry rock application

Weir Minerals has upgraded its range of Trio® TC live-shaft cone crushers. The Trio® TC84XR features all the robust design elements that have made live-shaft crushers a fixture of the mining and sand and aggregate industries for generations, while also incorporating the latest technology to ensure it remains integral to flowsheets long into the future. Engineered to perform in the most extreme applications, the Trio® TC84XR crusher is robust and easy to maintain and operate. It reliably delivers high crushing force and high performance in primary, crushed ore and quarry rock applications.

© Weir

The new Trio® TC84XR live-shaft cone crusher

"The Trio TC cone crushers' live-shaft design has been proven to perform in heavy-duty secondary and tertiary crushing applications. We wanted to build on this strong foundation. While the TC84XR may seem familiar on the outside, we've upgraded its design and control functionality. The motor is larger and it has a much higher crushing capacity compared to equivalent sized crushers," Mark Utecht, Weir Minerals' Director of Comminution Engineering says. "We now have an incredibly robust, powerful and technologically advanced crusher that is easy to operate, has a low wear rate and uses less energy, which ultimately lowers operating costs," he continues.

While many OEMs have made the decision to discontinue their live-shaft cone crushers, Weir Minerals has resisted this trend, believing that – because every mining and sand and aggregate operation is different – there can't be a one-size-fits all approach. There are some applications and situations where pedestal (fixed-shaft) style crushers may be the more appropriate solution, which is why Weir Minerals continues to manufacture both the TC live shaft and TP fixed shaft style machines.

"The combination of the Trio TP and TC fixed and live-shaft cone crushers ensures that Weir Minerals continue to offer their customers the right technology, regardless of their site structure, operating conditions or application," Mark Utecht, Weir Minerals' Director of Comminution Engineering said. Trio® live- and fixed-shaft cone crushers are made for modern mines and quarries with advanced hydraulics, wear resistant material and the latest technology.

Replacing existing live-shaft style machines on site with the Trio® TC84XR crusher is now a straightforward process because it has very similar dimensions and is a comparable weight to its live-shaft predecessors. And because it produces the same product, downstream changes aren't required, which isn't the case when replacing a live-shaft style machine with a fixed-shaft style machine. In other words, there is no need to re-design existing circuits.

The ability of the TC84XR crusher to handle variable feed and crush pebbles is also partly a result of its large motor; it's been designed with higher power capability than comparable cone crushers. Ultimately, this translates to a higher potential crushing force and therefore increase in production. Another feature that allows it to handle variable feed, as well as deal with tramp material safely, is the fully-automated tramp-release and setting recovery system. The tramp release hydraulics can also be used to safely clear the crushing chamber should a sudden disruption in plant power cause a shut-down of the cone crusher.

The socket assembly has been redesigned to improve sealing, which has optimised functionality and manufacturability by reducing the machining setups of the socket and seal rings. The Weir Minerals comminution team has also redesigned the countershaft assembly to remove welding and machining, while simultaneously improving venting and the dust seal.

The Trio® TC84XR crusher, like the range of TP series cone crushers, can be fitted with ESCO® wear parts, designed with superior ESCO® alloys, they can be custom designed based on customer specific requirements.
www.global.weir/trio

© SAMSON

Examples of Rail Mounted Eco Hoppers designed and delivered by SAMSON Materials Handling

Small environmental impact

Ship unloading with the SAMSON Eco Hopper

SAMSON Materials Handling got an order for an Eco Hopper from Bataan/Philippines. The unit is designed to receive coal which is unloaded at the quay area via crane grabs with a discharge direct to ongoing conveyors. Under standard conditions the discharge will achieve a peak rate of 1500 t/h, based on a material density of 0.85 t/m^3. Over all this project shows once more the succes of a tight collaboration within the AUMUND Group of companies, here especially with AUMUND Asia (H.K.) Ltd (China) responsible for this sales area and future support of the equipment whilst in operation.

Technical Specification and operation of the SAMSON Eco Hopper

The rail mounded Hopper has been designed by SAMSON Materials Handling and is based on the maximum grab dimensions and volumetric capacity of 45 m^3. The hopper is positioned between loading points by means of a basic tow travel design which includes non-driven rail wheel blocks, equipped with rubber impact buffers. Access platforms, walkways and handrails are included at all levels for secured maintenance and inspection purposes.

The Eco Hopper has a size of 7.5 x 7.5 m, a hight of 21.9 m above the quay and runs on crane rails. The hopper has sectional reinforcements which are integrated into the design to offer optimal strength and weight to the unit. The inner hopper shield is designed to isolate the dust filter elements from the main material flow and to optimise the filter operations.

The SAMSON Flex-Flap design and other filter systems

The inlet system of the Eco Hopper is based on the SAMSON Flex-Flap design which reduces the volume of air necessary to control dust both from the opening grab and displaced air from material falling into the inner hopper below. This design significantly contributes to the reduction of airflow, reducing filter and power consumption of the equipment. Additionally, the Eco Hopper includes a turbulence reduction system positioned above the Inlet Shroud. This system allows to reduce the wind turbulence above and inside the shroud which is commonly caused by cross winds. As a result, this system reduces the filtration airflow requirements.

The dust filters are located on three sides of the Eco Hopper. This keeps one side clear to allow for the grabs to pass over thus minimising the potential of material falling onto the filter system. The benefits of the Eco Hopper are that it captures all airborne dust generated when unloading coal from the vessel. It then efficiently transfers the coal to the quayside belt conveyors for onward transport to the storage/power plant.

www.aumund.com

Process reliability in salt storage

Trouble-free hall loading with Tecdos drive technology from RUD

© K+S

Process reliability in the salt warehouse: the optimized belt stacker in the warehouse in Borth

The Borth rock salt mine and salt works are located in Rheinberg, about 60 km from Düsseldorf. Between 7000 and 8000 tons of salt are mined and processed there every day. The plant is operated by K+S, Europe's largest salt producer. The salt extracted from the mine is first stored temporarily before being used, among other things, as road salt. Borth has a storage capacity of more than 250 000 tons of salt: 180 000 tons in underground bunkers and around 70 000 tons in a storage hall. It is precisely here, in the storage hall, that a drive solution from RUD ensures trouble-free hall charging with salt.

A movable belt stacker was optimized, which now runs without failures and with low maintenance thanks to the robust RUD Tecdos round link steel chain and the innovative drive system RUD Tecdos Omega Drive. The chain and drive were integrated into the existing steel structure. The specialists of the RUD Group, RUD System GmbH, Herfurth & Engelke Förderanlagen GmbH and RUD Ketten Rieger & Dietz GmbH and Co. KG, worked closely together on the conversion solution.

RUD Tecdos: the optimal solution for trouble-free drive in the salt storage system

"The round link chain in combination with the Tecdos drive is the optimal solution for us," Alexander Gils concludes. He has been working for K+S at the Borth site since 2013 and, as an operating engineer in the surface area, is responsible for maintenance and conversion work on the conveyor systems. "Previously, our mobile belt stacker ran by direct drive of the wheels via a gear motor and roller chain. But with the salt and humidity in the unheated warehouse, the wheels kept slipping or blocking on the tracks. At least once a week, the system failed and an employee had to pull the belt stacker by chain hoist. A rebuild of the system was unavoidable," says Alexander Gils, describing the problem.

The hall in Borth can temporarily store around 70 000 tons of salt. The conveyor system is located at a height of 20.7 m and has an approx. 70 m long travel path. With a conveying capacity of 500 t/h, it handles around 1 million tons of salt within a year, which corresponds to around 37 000 truckloads. High plant availability is therefore essential. To optimize process reliability, the new belt spreader drive system had to be robust against salt and moisture. Alexander Gils found what he was looking for with RUD and its Tecdos products.

Salt and moisture: no problem for the Tecdos drive system

The principle of the Tecdos drive system from RUD, which is in use at the conveyor system in Borth, is as simple as it is revolutionary: The Tecdos Omega Drive is attached to the SEW motor of the system and pulls itself along the horizontally tensioned Tecdos round link chain over the entire travel distance of around 70 m and it moves the belt stacker along the entire length of the conveyor. In this way, it moves the

© K+S

The drive system consists of the Tecdos Omega Drive and the Tecdos round link chain

belt stacker back and forth. The RUD divisions worked closely together for the construction and design of the components: The RUD System GmbH team took over the coordination and lead management of the project, prepared the manufacturing and assembly documents and took over the purchasing of the components. The specialists from RUD Ketten, in turn, were responsible for the design and manufacture of the chain components. Herfurth & Engelke Förderanlagen GmbH took over the manufacturing and assembly of the new system.

"Compared to other drive types, such as rack and pinion, spindle drives or roller chains, our Tecdos system is robust against aggressive media and harsh weather conditions. It is also predestined for use in salt storage facilities in particular. Damp fine salt is slippery, and wheels tend to lose their grip and slip. However, the Tecdos Omega Drive in combination with the round link chain keeps running," explains Managing Director René Heimlich, who is responsible for project coordination, design and component purchasing at RUD System GmbH.

Driving at a dizzy height

One challenge in the construction of the conversion was the limited space available and the statics at a height of 20.7 m. "The motto was: as big as necessary, as small as possible," emphasizes

© K+S

The drive system is particularly robust against aggressive media and weather conditions

© K+S

The optimized belt stacker operates at heights of over 20 m


© K+S

The Tecdos Omega Drive is directly attached to the SEW motor

Alexander Gils. For the drive, RUD chose its second smallest drive in the Tecdos Omega Drive series, the Omega Tec 12 with 12 kN tensile force. It scores with its compact dimensions of 280 mm x 102 mm x 250 mm (L x W x H) with a net weight of 22 kg.

The chain on the belt stacker is a RUD Tecdos round link chain Premium made of case-hardened steel. "We deliberately did not choose a stainless round link chain. For one thing, our case-hardened round link chain is more durable and also works despite corrosion. For another, we would not have been able to maintain the compact dimensioning otherwise," explains Heribert Herzog, application engineer at RUD Ketten and responsible for the design of the chain drive.


© K+S

Works despite corrosion: The RUD Tecdos round link chain made of case-hardened steel

Everything from a single source: from components to steel construction

The height at which the system is installed in the warehouse was also a challenge for the professionals from Herfurth & Engelke. "We had three fitters in harnesses up there at a good 20 m height. That's a bit more demanding in terms of occupational safety, and it also costs more time during installation. But everything worked out excellently," explains Olaf Uminski, Managing Director of Herfurth & Engelke Förderanlagen GmbH, which is also part of the RUD Group. In addition to the installation of the new drive system, the specialists for the conversion of existing plants also took over the manufacture of brackets, operating platforms and steel construction components.

The conversion and commissioning of the optimized belt stacker took place in the course of an annual turnaround at the K+S plant in Borth. The conversion was installed and commissioned within one week.

www.rud.com

The drive is pulled along the horizontally tensioned Tecdos round link chain over the entire travel distance of around 70 m

REMAREP ULTRA 10 black 1500 ml plus battery cartridge gun

Black version

REMAREP ULTRA 10 "Black": Ultra-fast belt repair now available for major damage

In 2020, REMA TIP TOP launched REMAREP ULTRA 10, a two-component repair material that significantly speeds up the repair of minor damage to conveyor belts. As of now, the product is available in a black version in significantly larger 1500 ml cartridges designed for major repairs.

Time is money – unplanned breakdowns of conveyor systems and long downtimes due to repairs often lead to high costs. The two-component repair paste REMAREP ULTRA 10 "Black" made of solvent-free PU in the new cartridge size helps to significantly reduce repair time, especially for major damage to conveyor belts as well as to PU, PVC and elastomer components.

With the new product, REMA TIP TOP is responding to the high demand from customers who are already successfully using the red 210 ml cartridges and require an equally reliable solution for larger conveyor belt repairs. Accordingly, the new black repair paste is available in larger units of 1500 ml per cartridge. A battery gun is used for easy and efficient application.

Like REMAREP ULTRA 10 for minor repairs, the new repair system for major defects offers exceptionally fast curing: at 24° Celsius, the hardness averages 65 Shore A after 15 minutes, and a repaired conveyor belt can be loaded after 60 minutes.

REMAREP ULTRA 10 "Black" offers similar wear properties as the original belt material and is resistant to UV radiation, oil and diesel fuel. The main applications of the repair compound are in conveyor belt repair, for example in case of damage to cover plates and longitudinal cracks in the conveyor belt, and in sealing punctures on belts.

Application of the REMAREP ULTRA 10 black

In addition to the repair of conveyor belts, the REMAREP ULTRA 10 repair material is particularly suitable for filling joints in rubber linings and for cosmetic repairs to PU, PVC and elastomer components. The repair can be done either by trained REMA-TIP-TOP service personnel or by qualified personnel at the plant operator's site.

With REMAREP ULTRA 10 in a red version for minor repairs and in the new black version for major repairs, REMA TIP TOP now offers a universal repair system for every demand.

www.rema-tiptop.de


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© Schenck Process

1 Rheinkalk uses CONiQ Monitor, a condition monitoring technology from Schenck, which is based on predictive maintenance

Intelligent cloud service

Rheinkalk augments production with CONIQ monitoring technology

Rheinkalk, part of the Lhoist Group, one of the global leaders in lime, dolime and minerals, approached Schenck Process with the need for a quick and effective solution to an issue they faced with two of their crusher relief screens. There were unexpected damages that resulted in significant costs and unscheduled downtime. Rheinkalk required support to determine the issue and establish a long-term solution around fault detection, fault prevention and to optimize the onsite operations.

The need for a smart service software solution

As the biggest limestone mine in Europe, it was hugely important for Rheinkalk to run their screens as efficiently as possible, maximizing throughput of around 7.5 million t/a and keeping close control over costs. They needed to ensure that any maintenance downtime was scheduled according to the production plan and was as short as possible. Any deviation from this schedule for damage or unexpected maintenance could considerably impact production.

The need for a solution that monitors trends and highlights issues upfront became immediately apparent to Rheinkalk when they discovered that two of their crusher relief screens were damaged precisely where the cross beams were located. They needed a product that gave them more time to react. A team of Schenck visited their site to take measurements and identified a general problem with natural frequencies.

Although Rheinkalk considered different solutions, Schenck's smart service solution offered features that were ahead of the competition, several of which included:

- The visualization and rapid setup of the system (within 2 to 3 days)
- The clarity of information regarding any irregularities

© Schenck Process

2 The necessary hardware was installed on the existing vibrating equipment and connected to the CONiQ Cloud

- Availability of service through a web connection
- Potential to recognize and identify trends by themselves
- Ongoing support from our team of experts
- Try and buy option: Customer can test the system for a couple of months (six months in general) and decide whether to buy it or not

By proactively proposing tailor-made solutions and recommendations to make the system more effective, the Schenck team demonstrated to the customer that they were aligned with them every step of the way.

Investment costs rapidly recovered

A greater understanding of the issues allowed confidence in waiting for any pre-planned maintenance to take place, optimizing the machine's efficiency, and preventing an unnecessary standstill. By avoiding one halt, Rheinkalk could immediately recover the cost of their investment. "We wouldn't have seen the damage. At least we would have seen it much later so that the consequential damage would have been higher and expensive," said Markus Beermann, Asset Manager stone processing at Rheinkalk. This quote from Rheinkalk proudly re-affirms that the Schenck team had achieved what the customer had set out to do:

- Solving the initial challenge
- Making established processes work more effectively
- Providing fast results that added value quickly

Smart service technology intuitively predicts patterns

The customer was impressed with the CONiQ Monitor, the condition monitoring technology from Schenck, which is based on predictive maintenance. It enabled the customer to realign their maintenance strategy and has been proven to save users significant

© Schenck Process

3 CONiQ® Cloud – a cloud-based IoT solution designed to access data from machine assets

amounts of time and money. By installing an intelligent application, designed to provide machine-specific knowledge, the customer could better understand wear and tear and better detect any faults. The application intuitively gains specific knowledge of the system, allowing the customer to review patterns and obtain information that enables easier determination of failures.

The versatility of the high-performing CONiQ Monitor meant the system was able to be attached to the existing infrastructure and worked effectively alongside the machinery Rheinkalk already had in place, even though it originated from a competitor. The quick installation process and ease with which the CONiQ Monitor works meant that it was up and running effectively within a few days. The necessary hardware was installed on the existing vibrating equipment and connected to the CONiQ Cloud. It thereby provided Rheinkalk with an immediate view into the condition of their machines.

Immediate impact on cost and downtime

Due to the installation of the new system, Rheinkalk was informed about an increase in lateral acceleration value, almost double the normal flow. The CONiQ Monitor suggested that the issue was the damage of a cross beam within the infrastructure. Rheinkalk was able to check the machine within the regular maintenance scheduled the following weekend when they discovered three damaged cross beams. The customer rectified the damages within the next planned shutdown without extra downtime, and the machine returned to normal function after the maintenance had taken place.

The belief in the system and its substantial benefits led Rheinkalk to introduce a "Try and Buy" option. This offer allowed the customer to utilize the CONiQ system for six months before deciding whether to purchase it. Through this scheme, Rheinkalk could see how robust and invaluable the product could be and the positive impact it would have on their business. There was no question of them returning it once the trial ended.

A diagnostic system that can monitor conditions continuously and proactively ensures that any machinery damage or deterioration is detected before downtime is required. Rheinkalk could use the technology to control the system remotely, guaranteeing a solution with longevity that would withstand any conditions no matter how harsh or rugged the environment. Full support for Rheinkalk' investment is offered throughout the system's complete lifecycle, including spares and service when necessary.

While monitoring performance and optimizing operation processes, the CONIQ Monitor immediately alerts the customer if an issue is detected. The data-driven solution provided a collection of important information and algorithms that improved processes. It quickly demonstrated to Rheinkalk how they could anticipate any failures, detect trends, and gain a unique long-term understanding of their equipment.

Schenck also offered training and assistance on interpreting and analyzing the system based on the data. It allowed the customer to build a maintenance strategy and establish whether they should rectify problems immediately or wait until the next planned maintenance. Nevertheless, dealing with issues before they become critical saves downtime and maximizes the service life of vibrating machines.

www.schenckprocess.com

1 Guaranteed weight accuracy along with time and cost savings during commissioning – thanks to the weigher initial calibration verification carried out by HAVER & BOECKER service experts

Everything in balance

HAVER & BOECKER celebrates its 100th initial calibration verification

The perfectly filled bag is clean, stackable and accurate in weight. Above all, weight accuracy is essential for producers and consumers, and thus calibrated weighing technology is required in order to guarantee the measuring accuracy of weighing equipment. As a certified weighing specialist company, HAVER & BOECKER has been authorized to carry out the initial calibration verification of weighers in accordance with EU Directive 2014/32/EU since January 2020. The family-owned company from Oelde/Germany has since carried out its 100th initial calibration verification in Europe.

Manufacturer's conformity assessment

"Before being put into operation for the first time in the EU or EFTA states, every weighing instrument has to be verified by a verification authority, a state-accredited inspection body or a certified manufacturer. Calibration verification confirms the accuracy within the permissible calibration tolerance," says Klemens Waldikowski, specialist for conformity assessment at HAVER & BOECKER. Whereas in the past an external testing authority first had to be requested after the installation of a system at the customer's site, today HAVER & BOECKER service technicians can now carry out the so-called "conformity assessment" themselves. "This saves time and final costs for everyone involved," explains Waldikowski. "There aren't always officials in every region to carry out calibration. So in the past there could be several days or weeks between installation and calibration. That's very valuable time for the customer." An initial calibration verification by the HAVER service team is quick and non-bureaucratic. The customer also saves on calibration fees and official inspections. "The authorities are only involved in the recalibration, as these are still subject to public authorities."

Calibration verification for conversions and upgrades

Initial calibration verification not only applies to new systems. Also weighing technology of old systems can also be initially calibrated by HAVER & BOECKER under certain circumstances. "The calibration-verification of a weighing system is only mandatory in the EU and EFTA countries. A second-hand machine that's returned to the EU and has never been calibrated thus falls into the category of initial calibration verification. This also applies to conversions of existing systems, provided the weigher is changed over to the current version," says Waldikowski. For HAVER & BOECKER customers – in addition to high, long-lasting quality of the automatic weighers – this means guaranteed weight accuracy and time and cost savings when commissioning new or modernized systems.

www.haverboecker.com

2 Manufacturer's calibration verification by HAVER & BOECKER for reliable weighing technology

"Steinhaus MLock"

Innovation out of tradition

© Steinhaus

Comparison of installation height of conventional screening systems ...

© Steinhaus

... and installation height with the "Steinhaus MLock" system screening tray

To mark its 100th birthday, Steinhaus GmbH from Mülheim an der Ruhr is presenting a world first with its patent-pending "Steinhaus MLock" system screen. Steinhaus GmbH is thus taking up old traditions. After all, the company is regarded as the inventor of polyurethane screens, ever since the first industrially manufactured screen made of polyurethane was introduced in 1968. This was followed as early as 1976 by the "Kombiplast" system; the world's first system screen and thus the forerunner of all system screens in existence today. The next milestone: The UNI 2000 system screen has been setting the standards in terms of open screen area for 25 years.

Following in its footsteps, "Steinhaus MLock" is now the world's first magnet-based and self-centering system screen bottom. Even if the system screens currently on the market are proven and established, they all share more or less the same weaknesses. Like the mounting bars permanently mounted on the screening machine, the screens themselves – or the corresponding mounting material – have to be driven in with great effort. This, of course, involves a risk of accident that should not be underestimated.

© Steinhaus

Mounting of adapter strips is possible from below

Why risk of accident? Often, the space above the screen bottom is also restricted, making it almost impossible to install the screens. Shower lines could perhaps still be temporarily dismantled for hammering in the screens. But, and the costumers have certainly already made this experience, in many cases the installation space is permanently restricted, for example under a feed box, a shaft protection tube, a drive bridge or even a dust hood.

At this point, an important note: The European standard EN 1009-4 for screening machines has already created new specifications with regard to ergonomics and occupational safety. As a rule, it must now be observed in the design of new screening machines that a clearance of 550 mm must be maintained above a screening floor if this space has to be walked on. This requirement applies to the clearance between the screen decks of a multi-deck screening machine in particular.

What is, of course, desirable for ergonomics and work safety, poses a great challenge to the manufacturers of screening machines, the plant engineers and also the operators. Where "classic" system screens are used, for example, circular vibrating screens with at least three screen decks will generally have to become much higher in the future. The three-deck circular vibrating screens frequently used in gravel plants, which are as compact as possible, can hardly, if at all, be built reliably in the future. The drive will be pushed so far out of the center of gravity of the screening machine by the design adjustments that such a screening machine will no longer be able to perform proper circular vibration. Attention. The consequence of EN 1009-4 is that modernization of existing plants is only possible to a very limited extent. The greater overall height also results in a higher weight, which not only leads to higher investment costs, but also to higher maintenance and servicing costs and a greater energy requirement. These effects act as a multiplier for economic efficiency on the entire plant design.

Side mounting with "Steinhaus MLock" adapter

Tool-free installation of the self-centering screen components

Solution: The problems mentioned are circumvented by "Steinhaus MLock" in an elegant way

The Steinhaus MLock adapter strip is installed once, in which strong magnets and positioning cams are incorporated. This adapter bar will be available for the most commonly used screening machine supports (hollow section and perforated angle longitudinal member). If angular longitudinal beams are installed in the screening machine, the adapter bars can even be easily mounted from below, without a hammering tool.

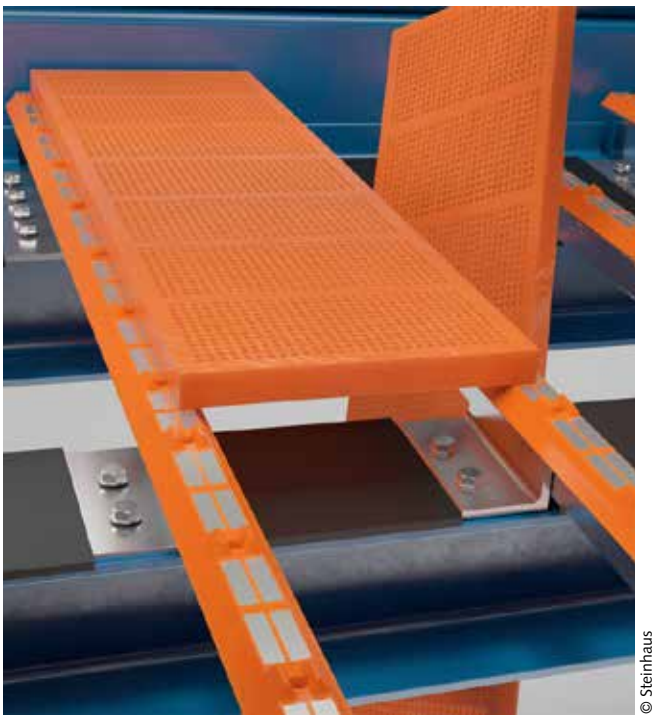
The screen elements themselves have a magnetizable counter pole and recesses for the positioning cams. When the screen components are inserted, each individual component finds the correct position by itself and is connected to the screen machine vibration-proof by the magnetic force. The screens can therefore be installed without tools and are therefore easy to install even in places that are difficult to access. For disassembly, the screen bottom only has to be slightly levered out on the front side. Since the holding forces are immediately reduced by releasing the outer magnets, the screen bottom can be removed just as quickly and safely as it is installed.

Multi-deck screening machines do not have to be built higher – as is the case when using classic system screens – due to the specification of EN 1009-4. "Steinhaus MLock" can simply be installed from below, i.e. from underneath a screen deck. Since the screen deck does not have to be walked on in this case, the clearances specified in the standard do not have to be observed. Installation can therefore be carried out quite simply from the hopper, for example. Even more clever is a screening machine design in which, starting from a screening deck with a larger clearance, a narrower screening deck arranged above it can be changed. Thus, contrary to all fears, screening machines can even be built slimmer than ever before. Your advantage: savings on the cost side and on resources.

Of course, the screen decks for the "Steinhaus MLock" system are also offered in the Steinhaus quality and variety known on the market. Highly wear-resistant polyurethanes in various hardnesses, hybrid screens with wire cloths, press welded meshes, harps, perforated plates, slotted screens or even bar sizers. The entire product range from Steinhaus GmbH is also available for the "Steinhaus MLock" system.

Autor/Author: Ludger Lang, Sales and Product Manager Screens, Process Equipment & Wire Belts, Steinhaus GmbH, Mühlheim an der Ruhr

www.steinhaus-gmbh.de



Ergonomic mounting of the screen components from below

Optimise productivity from mine to market

From operational silos to integrated decision making


Open pit mine

© Seequent

If mining companies are to survive in the 'new normal', they must optimise productivity from mine to market. However, particularly in industrial minerals mining, there is often a disconnect between different departments with operational silos preventing close collaboration, ultimately leading to inefficiencies and lower productivity. James Edwards, Senior Geologist, Seequent, argues why mining companies must tap into digital workflows and collaborative technologies to fast-track productivity.

Sliding productivity challenges

Commodities are more in demand than ever and traditionally mining companies would respond by ramping up production. However, the age-old cycle that drives the mining industry is not what it used to be. Key elements such as extraction and production are more challenging, mining sites are moving further away from established infrastructures and accessing resources is more complicated.

It's getting harder to extract value because both the quality of the resources and ease of access is dropping off. Now, mining companies must tap into new digital workflows and collaborative technologies to fast-track productivity and create a new upwards trajectory.

Prevalent challenges in mining

Currently in many mining operations there is a disconnect between departments, there are operational silos and a lack of collaboration means companies are failing to optimise their operations to get the best value from their efforts. COVID did accelerate some of these challenges, but the industry has been heading this way for many years. In industrial mineral mining a lot of the easy to find precious and non-precious metals and minerals have been extracted, so companies are having to explore deeper often in more extreme environments where it's harder to navigate and more challenging to extract and transport materials.

When companies move into the less explored territory, there are two significant issues. The first is that local communities may not be receptive to new quarries being opened as disruption and the looming consequences of pollution to the local area are big concerns. The second issue is that resources need to be co-located and transporting materials can be costly. The shorter the distance from mine to the market, the better. So, with the pushback and the increasing difficulties with new territories, it's a perfect storm.

Industrial mineral businesses have always been up against the challenge associated with 'licence to mine'. There are huge environmental implications regarding waste and managing emissions within mining, and they are under the spotlight. The government and the public are more aware than ever of these critical issues and the impact they can have on local communities, and so there is constant pressure to place more emphasis on ESG issues such as sustainability, reducing waste and lowering emissions to achieve a circular economy.

As a result of these growing pressures in the new operational landscape, companies need to find ways to step up and find better ways of doing things. To do any of this they need to address operational issues at the very core of their business.

What data management and streamlined operations can do

How do they move towards a more cohesive approach? The first step is data management, which will give them a complete, comprehensive picture and critical insights across their entire operation.

Data is an asset for any company for driving fast, dynamic decision making, at every phase of the process, and in delivering compelling results. Having a multidisciplinary team, potentially scattered across geographies, makes this complex. But when your data is well organised and easily accessible, you can bring together all these different teams, sources and information to work as one and make rapid accurate decisions while saving time and money.

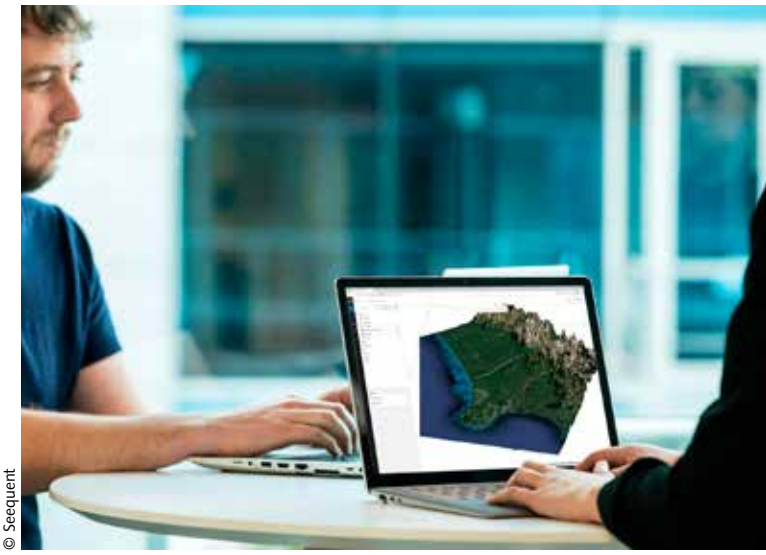
A consolidated approach means that data is accessible instantly and understood easily. When new ground is exposed, or new minerals are discovered, key information about the environment and landscape can appear in an instant before the right people, allowing them to make fast, informed decisions. Data is a highly powerful tool which, when wielded effectively can drive tangible operational efficiencies. However, unless it is usable and harnessed in the right way, you're not actually getting any value from it, indeed it can actually end up costing time and money.

What enablement companies can do to support mining

Collaboration is a key requirement of geological modelling and decision making. As projects are becoming increasingly complex, transparency, teamwork and stakeholder engagement are required to ensure all operational aspects and key information is considered and funnelled to the right people at the right time. Understanding and improving workflows and addressing challenges using a robust peer-reviewing process is the key to unlocking value from your deposit and progressing your projects to the next stage.

With these kinds of improvements, companies can keep tabs on emissions, high-risk environments and health and safety. If mining companies are handling high-risk materials that produce sulphur or create acid drainage, for instance, they need to handle it in the right way with the right information.

Seequent is supporting customers with their operations by creating digital twins that consolidate data from any source, transforming it into meaningful insights and connecting it to the appropriate geological or mining activity. Users can easily access, share, integrate and extract insights from their high-quality geoscientific data and in the process reduce costs and errors, save time, and facilitate auditing. This can all be done in the cloud too, so this data can be accessed wherever and whenever.



© Seequent

Seequent brings together industry-leading earth modelling, geo-data management, and team collaboration software to make better decisions across the lifecycle of projects

Digital twins help teams understand the natural variability of the operational environment, including changes in rocks and mineral concentrations, which ones are 'good' and 'bad', where they are located as well as what their volume is. They help teams to understand, communicate, and plan for future endeavours, and improve the value of what you can get from the ground.

It's not complicated either. The interfaces implemented to run the software is intuitive, easy to use, and the sharing of results, changes and messages to a wider audience can take mere minutes. It encourages collaboration around the interrogation of the data so teams understand disparities, the overall picture of operations, and how it'll directly impact the work they're doing.

This then empowers them to make not only timely decisions but repeatable, consistent ones, backed up by the context that comes from months and years of collected data. None of this will ever be lost either – gone are the days of manual spreadsheets that can be deleted or corrupted in an instant – the right technology protects and safeguards huge back catalogues of important work. With no big installation cost, or huge amounts of time spent on upskilling and training, companies can spend more time focused on what's important to them.

Mining is complex, challenging and not getting any easier. Consolidating and rationalising data with the right blend of technology and support gives teams the freedom to spend their time on the important tasks they're best at, rather than scrambling through endless, unsorted data. It enables exploration, testing and retaining research, so companies can make the most of what they've discovered and create efficient processes that will reduce negative impacts on the earth.

www.seequent.com

The BULKINSPECTOR automatically and precisely measures the skeletal density of bulk materials

Automatically reproducible

Newly developed PYC 130-A automatic gas pycnometer

Anyone studying chemistry, materials science or process engineering will soon encounter a need for the measurement of density. But how accurate and repeatable are the results obtained using a manually filled pycnometer? Are the external parameters within the standard range, or are deviations determined and included in calculation?

All these questions were asked by the originators of the development and construction of an automatic pycnometer: Prof. Dieter Schwechten, working until 2020 at the Konstanz University of Applied Sciences, now retired, and Jens Corell, of Siebtechnik GmbH. Jens Corell has, since 2000, been the head of department in the technical sector of sampling, comminution and laboratory equipment at Siebtechnik GmbH.

Statement of particle density is an elementary physical property for the characterisation of particles and bulk materials and is frequently needed in industrial processes. Measurement of true or particle density using gas pycnometers is thus a daily requirement in particle technology. Manual measurement, however, is complex, time-consuming and extremely sensitive to operating errors. A single measurement takes around 15 minutes, and the time needed then accumulates very significantly for systematic series of tests or measurements for process monitoring. For this reason, the idea was evolved in Prof. Schwechten's process-engineering department at the Konstanz University of Applied Sciences of developing a fully automatic gas pycnometer with an integrated scale for routine measurements. "Measurement of density was, actually, only an initial output variable, which

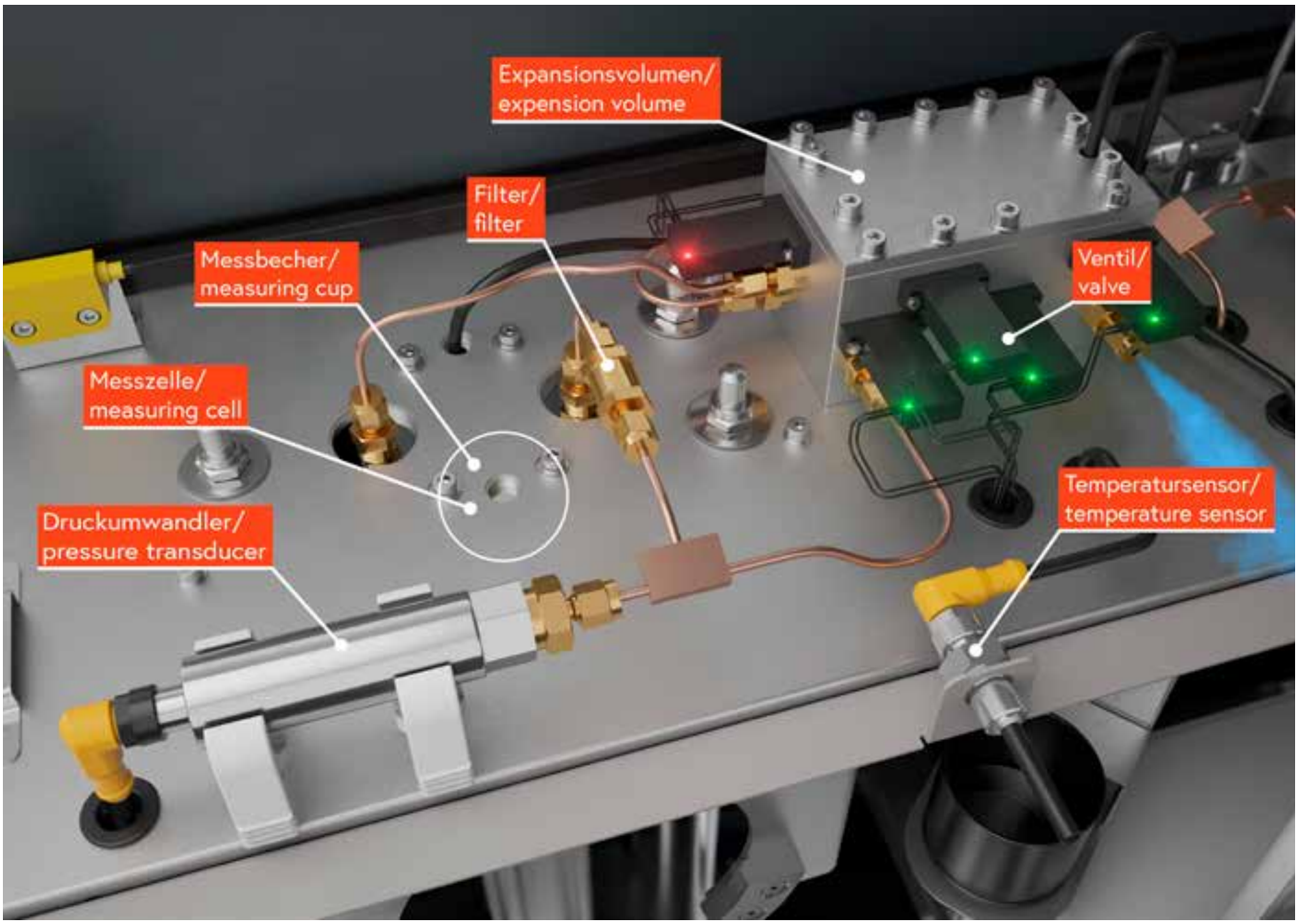
students with me were to perform. Further properties, such as mass flows and balances, were then to be calculated using this. If the pycnometer measurements themselves were already incorrect, however, no useable results could, of course, be obtained for the mass balances. This, of course, greatly frustrated the students! And I thought to myself that an automated density measurement system would be exactly the right remedy," Prof. Schwechten recounts on the origin of his idea.

Suitable industrial partners to make reality of such an idea were lacking, however. In such cases, the best solution is to turn to long-established, tried-and-proven contacts. Jens Corell and Siebtechnik GmbH were consulted at a POWTECH tradefair. "The chemistry was right, and we quickly reached agreement," Corell recalls, concerning the genesis of BULKINSPECTOR. "BULKINSPECTOR fitted well into our range, since we already had many years of experience in developing sampling systems and downstream systems for analysis."

Manual particle density measurement of bulk materials using pycnometers encounters a number of disadvantages. One is sampling. You need a homogeneous and representative random sample of the total quantity. Weighing-in must be performed extremely precisely. Non-conditioned samples and/or measuring receptacles can cause significant deviations in measurement of density, since a pycnometer is used to determine volume, which is, of course, dependent on temperature. And, in addition to these frequent sources of error, there is also a whole series of others that can affect the measurement. An automatic mechanical measurement system eliminates these sources of error and significantly improves the precision and scatter of the measured data. A further benefit is the enormous time-savings, and with automatic sampling and feeding of the measuring instrument, for example, complete series of samples can be measured overnight with no personnel present.

After a development period of around two years, BULKINSPECTOR was launched on the market in January 2022. This was preceded by an intensive interchange between Prof. Schwechten and Siebtechnik GmbH. Students from Konstanz University of Applied Sciences were given the opportunity at the Siebtechnik technology centre in Mülheim to perform series of statistical measurements in order thus to optimise the functioning of the pycnometer.

The PYC 130-A BULKINSPECTOR is a fully automatic mensurational system for measurement of particle or "true" density. The specimen material is inserted from the exterior to the instrument, ideally using a sample magazine. The sample is then inserted into the measuring cell using a handling device and the volume of the sample determined by means of multiple measurement. The handling device then conveys the specimen to the scale, in order to establish the mass of the specimen. Density is then calculated and outputted. Finally, the handling



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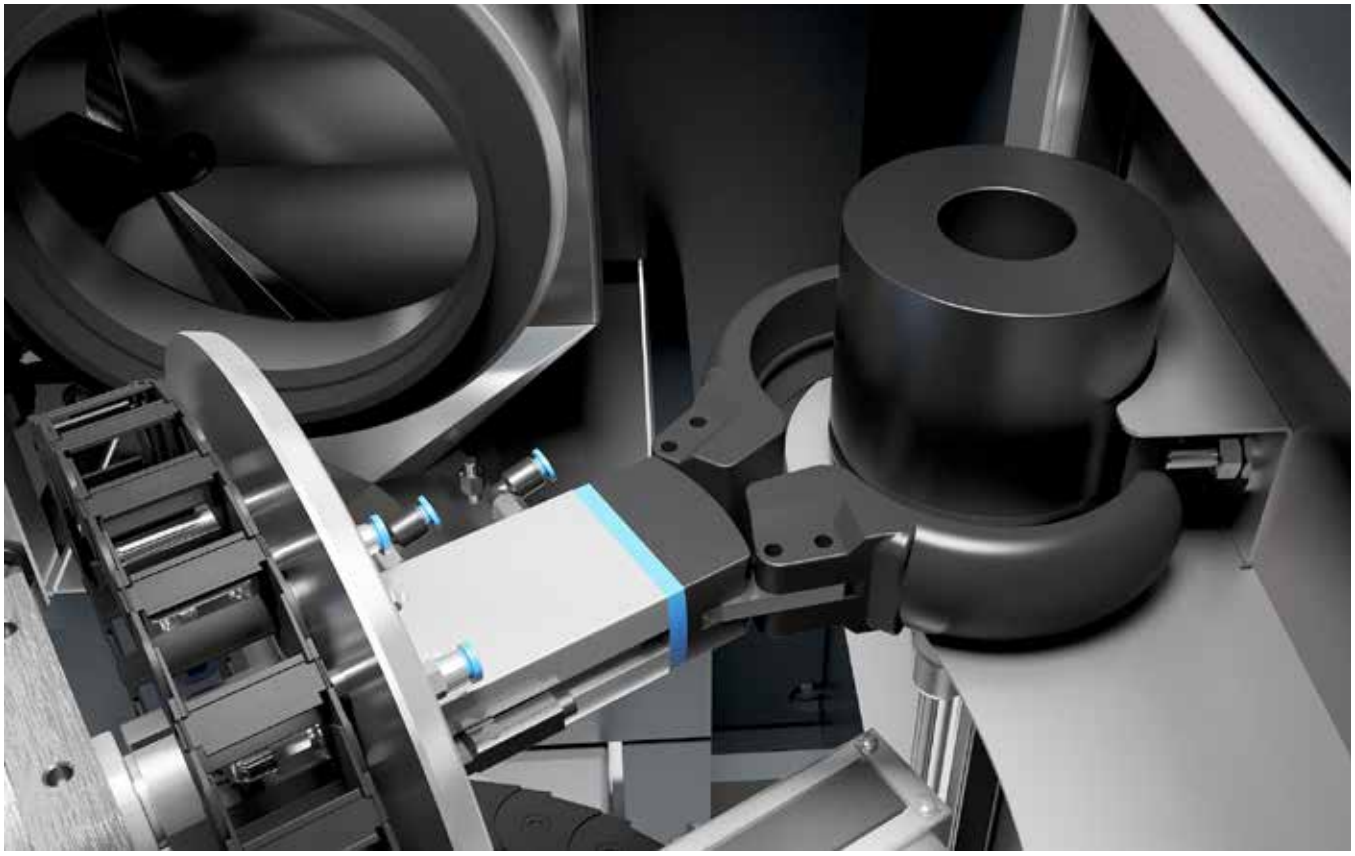
Structure of the automatic pycnometer BULKINSPECTOR



The integrated sample handling device automates the filling of the measuring cups, which contributes, among other things, to increasing the accuracy of density measurements

device discharges the measured specimen of material into a used-material receptacle. The measuring cup is cleaned using compressed air and is then ready to accept the next sample. One of the cup positions can be fitted with a calibration volume for automatic calibration, with the result that recalibration can be performed. Temperature in the interior of the insulated measuring system is maintained constant by means of a Peltier element.

The instrument is operated using a tablet supplied with it. The modern software which comes with the analysis system also originates from Siebtechnik and has been specially developed for this instrument.

A modern, user-friendly man-machine interface is available to the user thanks to an app installed on the tablet. Both measuring regime and measuring records can be stored on the tablet. The developers attached importance to sample traceability and test-inspection monitoring. This data can be viewed at any time and is also not lost if a power failure occurs. The operator also has access to the operating manual and can enquire directly with Siebtechnik GmbH for replacement and wear parts.

Possible applications are extremely varied and diverse (see information box). Jens Corell describes a fictional practical application of the BULKINSPECTOR as an example: "A measure-

The measuring cups are automatically cleaned ...

... and the already measured sample material is collected in a sample collection container

ment of density is to be performed using BULKINSPECTOR from a flow of bulk material of 100 t/h with a particle size of 0.3 mm. For this purpose, a downpipe swivel sampler is installed in a 300 mm diameter downpipe. This takes an individual sample of 1.4 kg using a rotating slotted vessel. Sampling should take place every 2 min., in order to assure adequate sampling frequency. Since the individual sample quantities would be too large for the BULKINSPECTOR, they must previously be split. For this purpose, a collective sample of 4.2 kg is generated from three individual samples and is then reduced in a turnstile divider to an analytical quantity of approx. 100 g. The splitting ratio can be variably set, for other services and other bulk densities. Screw and piston samplers can also be used in industrial applications. There are limitations on the sample-material side with respect to consistency – the samples must consist of pourable, non-glutinous material. The upper limit of the particle-size range currently measurable is around 20 mm."

Numerous other applications, such as the determination of bulk-material compaction, examination of cavities in metallurgy and in 3D production would also be possible using the BULKINSPECTOR. The two developers find especially exciting the potential of on-line integration of process monitoring and on-line Quality Control, which has up to now not been possible using off-line determination in the field of density measurement. In addition, batch processing of samples using the automatic sample magazine, which can accommodate up to fifty individual samples, would be possible overnight.

© Siebtechnik GmbH

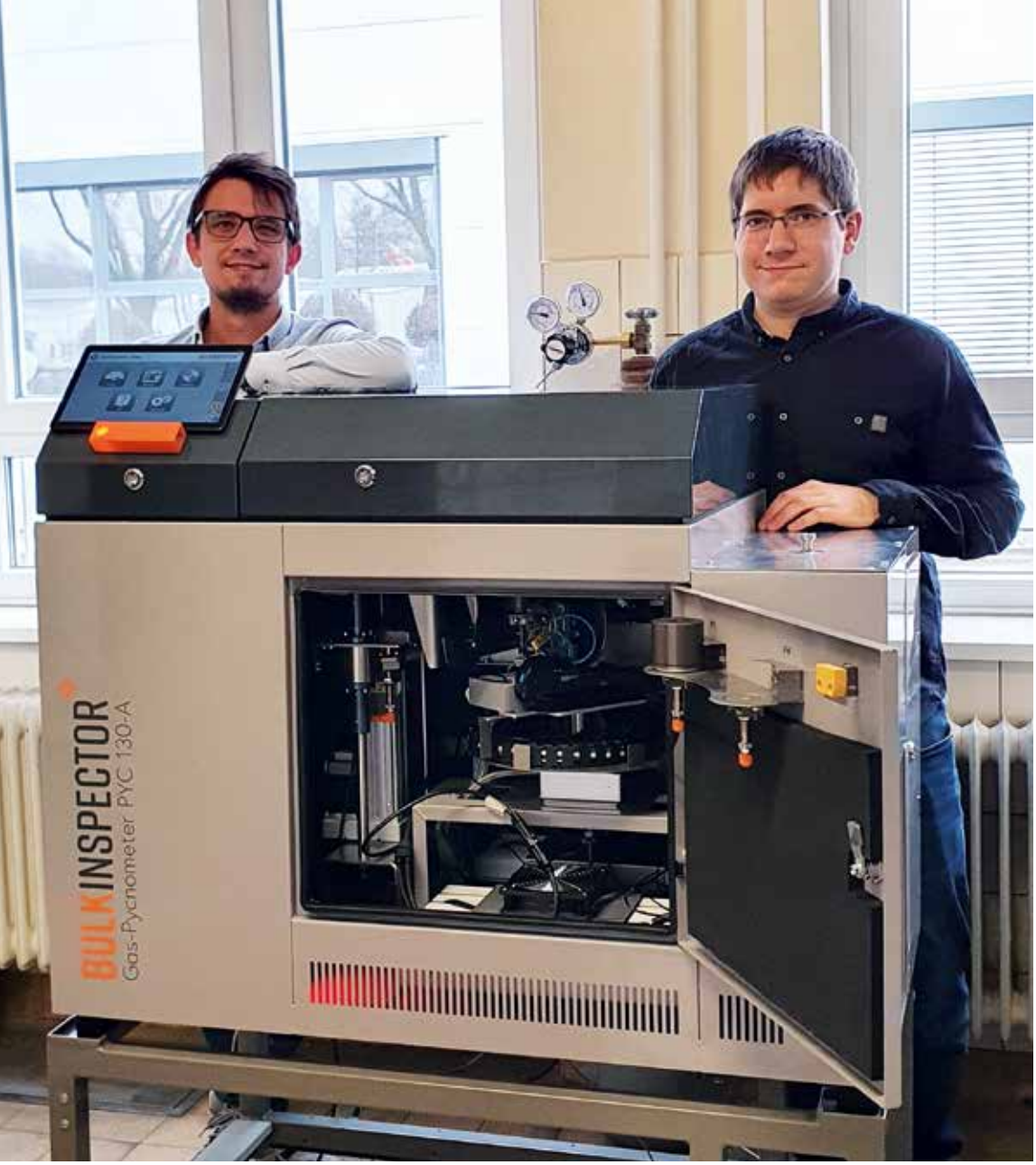
An application example for a series measurement with the BULKINSPECTOR could be e.g. these concrete drill cores

© Siebtechnik GmbH

A tablet with the BULKINSPECTOR app is available to the user for controlling the unit

© Siebtechnik GmbH

Prof. Dieter Schwechten and Jens Corell consider the possibility of online integration in process control and online quality control with the help of the BULKUNSPECTOR as particularly exciting



M. Eng. Oliver Born (left), since November 2019, and B. Eng. Marc Schumacher (right), at SIEBTECHNIK TEMA since March 2018, have been in charge of the BULKINSPECTOR project from the beginning (early 2020). Oliver Born is responsible for the development of the programming, Marc Schumacher for the constructive elaboration

Questioned about the future of this new automatic density-measurement instrument, Schwechten and Corell are convinced that this up to now unique system will be open to a broad range of applications, thanks to its precision and its automatic, unmanned operation. Siebtechnik GmbH currently offers test measurements using the BULKINSPECTOR at its Test Centre in Mülheim an der Ruhr. Production for worldwide marketing has already started.

Author: Dr. Petra Strunk, Editor in chief
AT MINERAL PROCESSING, Bauverlag BV GmbH, Gütersloh

www.siebtechnik-tema.de
www.bulkinspector.com

Potential applications for BULKINSPECTOR

- Powder metallurgy: Measurement of sinter and casting densities for examination for cavities
- PET coke: Determination of porosity
- 3D printing, additive production: Component characterisation, including determination of solids content
- Pharmaceuticals: Determination of tablet compaction and of porous inclusions
- Cosmetics: Determination of porous inclusion in lipsticks
- Roller compaction, bulk-material compaction
- Determination of properties/features: Product purity, chemical conversion by reaction, water content, thermal coefficient of expansion, …
- Plastics/composites: Determination of filler content
- Construction industry: Determination of material density/porosity
- Geology: Measurement of the porosity of drill cores

BULKINSPECTOR PYC 130-A: Technical Data

Model:	PYC 130-A
Measuring cup volume:	130/65/10 cm^3
Number of positions for measuring cup:	4
Sample gas:	Helium
Measuring pressure:	0 to 140 kPa
Scale:	0 to 510 g ± 0.0001 g
Measuring temperature:	15 to 35° C
Calibration method:	Automatic calibration using calibration sphere
Measuring uncertainty:	± 0.02%
Data interface:	WLAN
Dimensions (width x depth x height):	1100 x 675 x 855 mm
Weight:	190 kg
Power supply:	AC 110 V/16 A/60 Hz, AC 230 V/10 A/50 Hz

© NW Gypsum

Gypsum waste being offloaded at New West Gypsum Recycling to become new plaster-board

Dr.-Ing. Joachim Harder
OneStone Consulting Ltd., Varna/Bulgaria
www.onestone.consulting

Joachim Harder (1952) studied process engineering at Braunschweig University of Technology and earned his Ph.D. there. After more than 10 years working in industry in various management posts, in 1997 he established the consulting company OneStone Consulting. Dr. Harder is an acknowledged expert in international marketing, specializing in market analysis for business segment strategies. He is the author of diverse publications and a popular conference speaker.

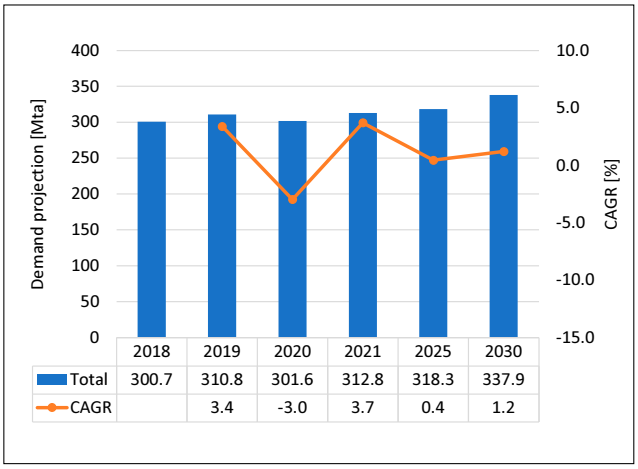
Forecast

Gypsum – a scarce raw material?

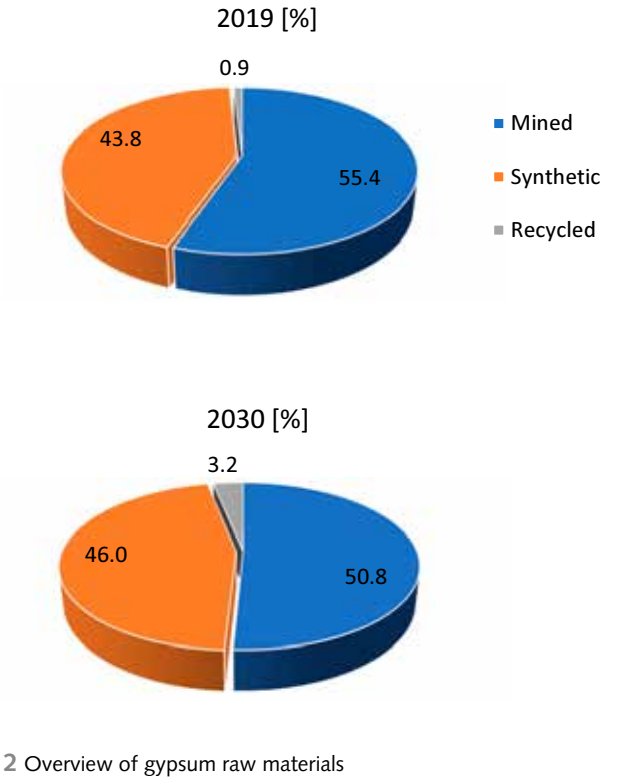
The premature decommissioning of power plants in Europe and elsewhere along with the corresponding sharp decrease in the quantities of flue gas desulphurization (FGD) gypsum are stoking fears that in a few years' time there won't be enough gypsum available for a growing market. In the following report, we look at the current global figures and, especially for Europe, we gauge the future prospects and what developments may be necessary.

1 Introduction

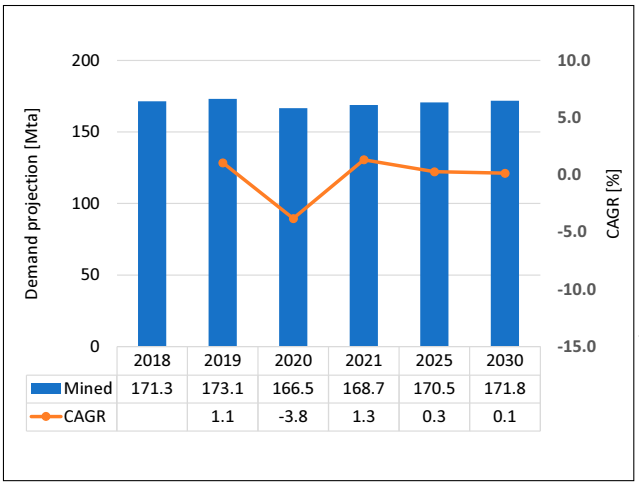
Gypsum is a key raw material needed in large quantities in the cement industry, the gypsum plasterboard industry, for other gypsum building products, and in agriculture. Fig. 1 shows how the global demand for gypsum will change over the next years [1]. According to this, gypsum consumption will increase from 310.8 million tonnes per year (Mta) in 2019 to around 337.9 Mta in 2030. Because of the pandemic, consumption decreased by around 3 % in 2020, but the market recovered markedly in 2021. In 2019, the cement industry, where gypsum is used primarily as a setting regulator, used 166.0 Mta, accounting for around 53.4 % of the demand for gypsum, followed by the gypsum plasterboard industry with 112.6 Mta or 28.3 %. In the forthcoming years, on account of the forecast peak in the cement industry in China, the global quantities required by the cement industry will decrease, however, the quantities needed for the gypsum plasterboard industry as well as those for other industries will increase.



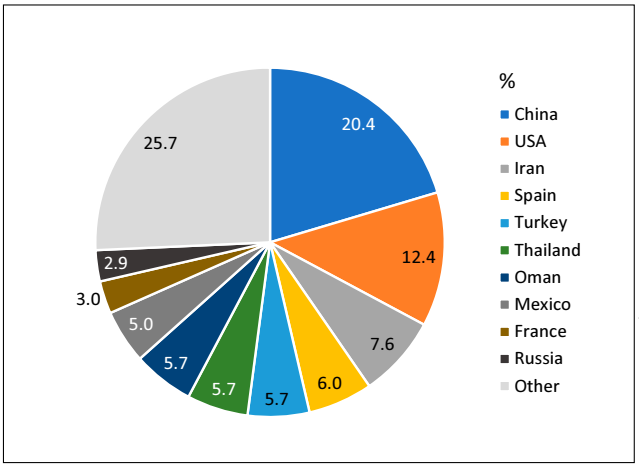
1 Global demand for gypsum



2 Overview of gypsum raw materials



3 Overview of natural gypsum production



4 TOP 10 natural gypsum production countries (2019)

Fig. 2 shows how, starting from the situation in 2019, a forecast for the global demand for gypsum as a raw material gypsum in the year 2030 can look. According to this, the percentages for natural gypsum will decrease from 55.4 % to 50.8 %, although in absolute terms, the production of natural gypsum will only decrease insignificantly from 173.1 Mta in 2019 to 171.8 Mta. The use of synthetic gypsum will not only increase in percentage terms by 2.4 %, but also clearly overall from 136.8 Mta to 155.7 Mta. At first glance, this may not be apparent as losses for FGD gypsum are forecast, however, there are numerous sources for synthetic gypsum. For gypsum recycling, high growth rates from a low level to 3.2 % and absolute quantities of around 11 Mta are expected.

2 Production of natural gypsum

Fig. 3 shows the forecast curve for global production of natural gypsum up to 2030. In 2020, on account of the pandemic, the quantities produced fell by -3.8 % to 166.5 Mta. For 2021, a slight recovery by 1.3 % to 168.7 Mta resulted. In contrast, over the years 2025 to 2030, only a smaller further increase in production quantities is expected. The major production countries for natural gypsum are shown in Fig. 4. China leads the field, with a global market share of 20.4 %, followed by the USA and Iran. The TOP 10 countries make up a market share of around 75 %. Some of the previously important countries, such as Thailand and South Africa, will continue to lose ground as the resources available there have already been largely exhausted.

© Kunooz Gypsum

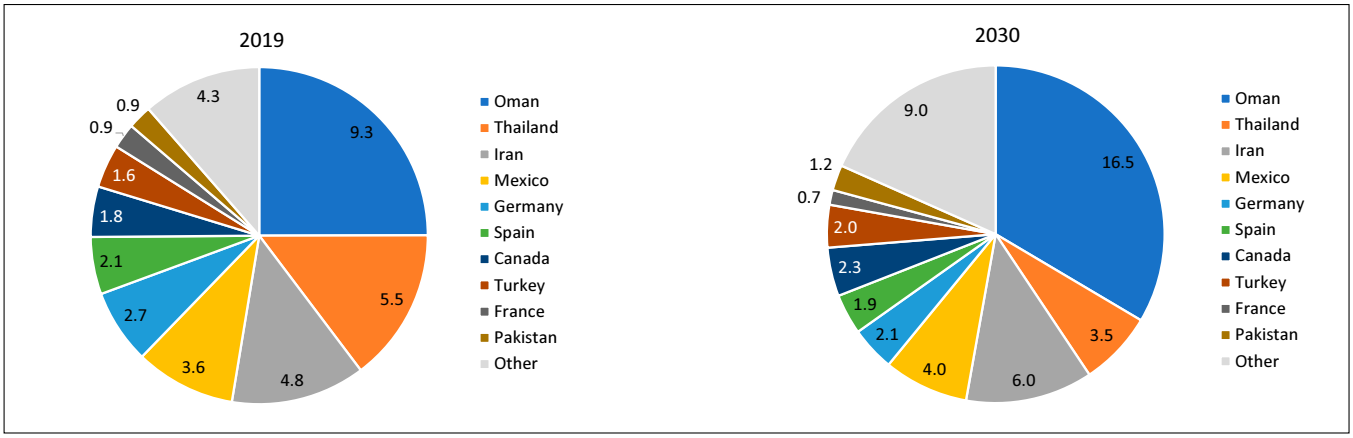
5 Natural gypsum extraction in Oman

The winners include countries like Oman and Iran, which still hold extensive reserves (Fig. 5).

This will also have an effect on the most important export countries for natural gypsum. In Fig. 6, the TOP 10 export countries for 2019 and 2030 are shown. Overall, exports totalled 37.3 Mta in 2019. Up to 2030, exports will probably increase to 49.2 Mta. Oman may be able to almost double its exports from 9.3 Mta in 2019 to 16.5 Mta. Iran's exports will also increase substantially from 4.8 Mta to around 6.0 Mta. The countries with higher export rates up to 2030 will include Mexico, Canada, Turkey and Pakistan. Considerable losses are expected for Thailand. After 5.5 Mta natural gypsum exports in 2019, a maximum of 3.5 Mta are expected by 2030. Germany will also reduce its export rates, too, as less FGD gypsum is available for domestic industry and this must be offset to an extent by more natural gypsum.

3 FGD gypsum and other synthetic gypsum

In the desulphurization of flue gases and various chemical processes, e.g. the production of hydrofluoric acid and phosphoric acid or the processing of dilute acid from titanium dioxide production, sometimes large quantities of synthetic gypsum are produced as a by-product. One speciality is evaporite gypsum, which is formed during the evaporation of seawater for the production of salts. In 2019, a total of around 435 Mta synthetic gypsum was produced worldwide (Fig. 7). Of this quantity, 136.8 Mta or 31.4 % were used in industry. Of the 176 Mta FGD gypsum produced, 72.8 % were used worldwide. In the case of phosphogypsum, of the quantity of 247 Mta produced, only 3.4 % were used in the cement and gypsum industry. All other chemical gypsums, such as fluorogypsum, titanogypsum and others, have not yet been used in industry on account of harmful impurities. Evaporite gypsum has so far been used mainly in India.



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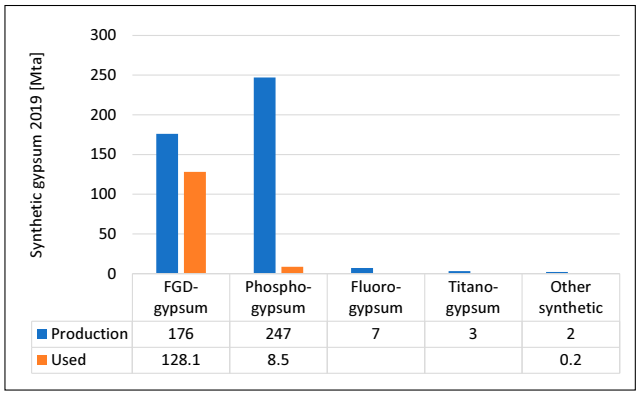
6 TOP export countries for natural gypsum in Mta



7 Production of synthetic gypsum

Coal-fired power plants currently still constitute the most important source of energy for the generation of electricity in many countries in the world. In countries like China, India and in various countries in Southeast Asia, more coal-fired power plants are being built. According to the International Energy Agency (IEA), depending on the CO_2 scenario, the global power plant output will rise from 7484 GW in 2019 to between 13 400 and 16 550 GW by the year 2040. FGD plants are also currently being upgraded in countries like India, Australia and South Africa (**Fig. 8**), which have so far not used the technology. Therefore, our forecast expects that worldwide FGD gypsum quantities will only decrease insignificantly from 176 Mta in 2019 to 173 Mta in 2030. **Fig. 9** shows what share the countries and regions will have in this time period. Losses in North America and Europe contrast with gains in China and the rest of the world (ROW).

Interesting is that not all the FGD is being used by a long way. **Fig. 10** shows how the figures have changed in recent years in EU 15 (Western Europe). The quantity of FGD gypsum produced fell from 11.45 Mta in 2008 to 7.04 Mta in 2019, the recycling rates increased from 77.3 % to 79.3 % in the same period. A not insignificant part of production, amounting to 1.14 Mta in 2008 and still 0.65 Mta now, is sent to so-called mono-landfills, where the FGD gypsum is not mixed with other substances. Similarly large quantities are sent for disposal, that is to landfills where the FGD gypsum is mixed with, for example, fly ash of inferior quality. The latter FGD gypsum from mixed landfills is lost for later recycling. The gypsum

8 Matla 2 coal-fired power station in South Africa

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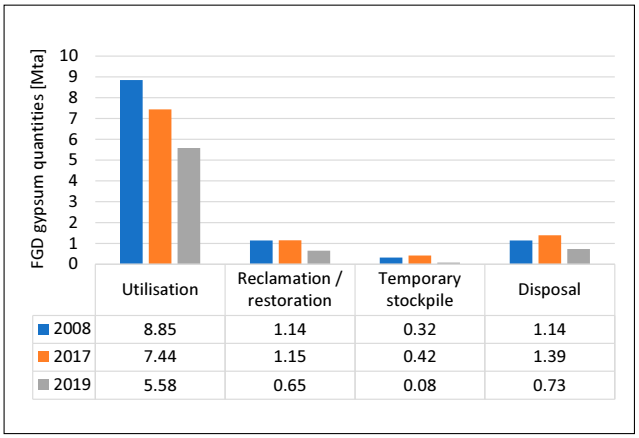
9 Overview of FGD gypsum by countries/regions



	Utilisation	Reclamation / restoration	Temporary stockpile	Disposal
2008	8.85	1.14	0.32	1.14
2017	7.44	1.15	0.42	1.39
2019	5.58	0.65	0.08	0.73

© ECOBA

10 FGD gypsum use in EU15

from mono-landfills, on the other hand, can be utilized at a later date.

Estimates assume that in Germany alone around 18.0 mill. tonnes (Mt) FGD have been sent to mono-landfills over the last 20 years. The biggest mono-landfills in Germany are located at lignite-fired power plants. One of these is found in Jänschwalde. The gypsum landfill there, Jänschwalde II, has been run since 2011 in two-shift operation for the FGD gypsum from LEAG's Jänschwalde 6 x 500 MW lignite-fired power plant. The delivered gypsum is placed in the landfill by means of a rail-mounted spreader (Fig. 11) and reclaimed with a wheel-loader (Fig. 12). Depending on the location and form of the gypsum landfill, reclaimers can be used for loading the gypsum at other sites. In the planning, it is expected that gypsum can be extracted from

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11 Jänschwalde II landfill for FGD gypsum

12 Reclaiming FGD gypsum from the gypsum landfill

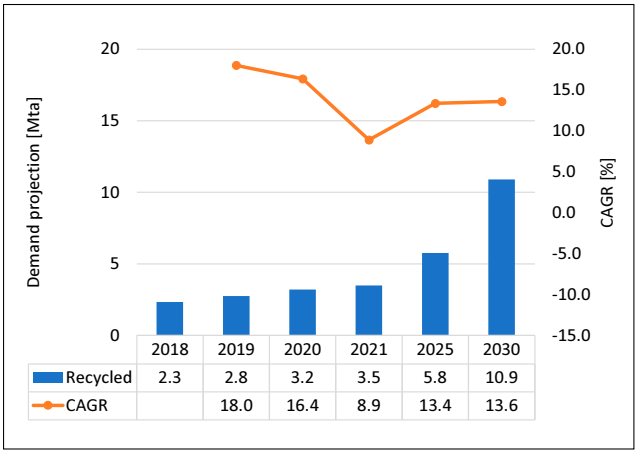
such mono-landfills without any detriment to its quality for up to at least ten years.

4 Gypsum recycling

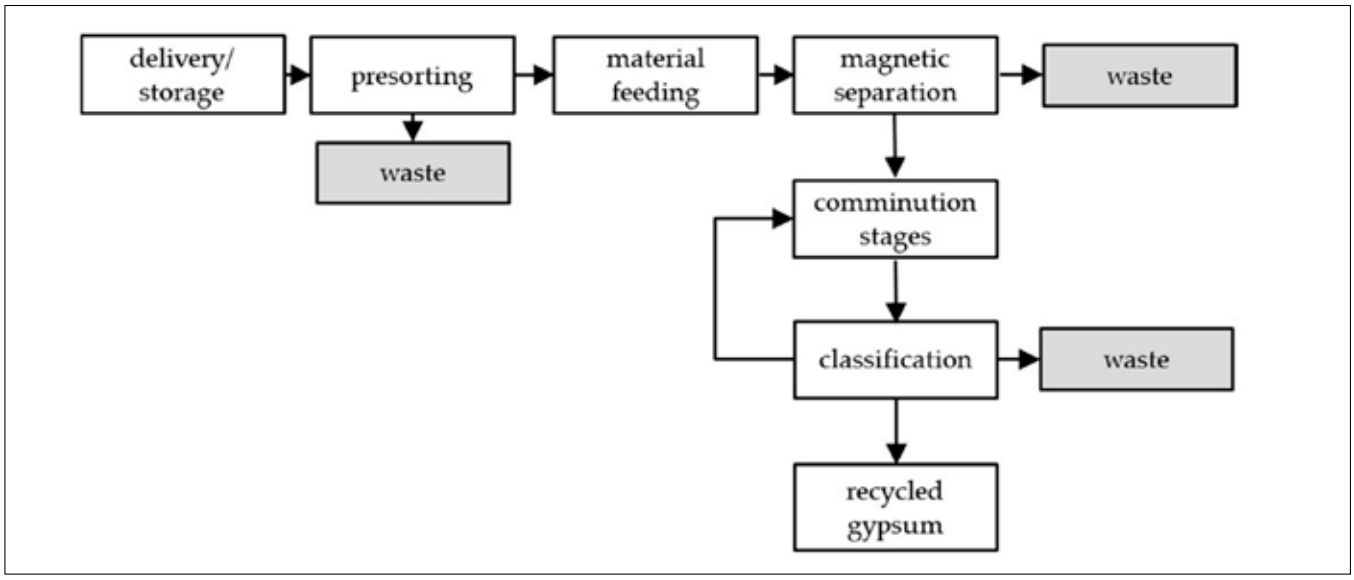
Although there are practically no limitations on the recyclability of gypsum, on a global scale, only very small quantities of gypsum have been recycled so far (Fig. 13). But here there is also great potential for growth. In Germany, according to a recent monitoring report headed "Kreislaufwirtschaft Bau" on recycling in the construction industry, around 0.64 mill. t gypsum waste are produced annually, but only 0.03 mill. t or 4.7 % of this are recycled. Gypsum waste is produced, for example, at construction sites as cuttings during the installation of gypsum plasterboards as well as during the refurbishment or demolition of buildings. On account of its sulphate content, gypsum waste should be collected separately from other construction waste and recycled. The problem here is that the gypsum from gypsum plasterboard and gypsum wallboard can be easily recycled, whereas gypsum from aerated and cellular concrete, gypsum fibreboard, screed and gypsum plaster has so far been mostly completely unsuitable for recycling.

Fig. 14 shows a schematic of the process stages at a typical plant for recycling gypsum waste. The main process stages are presorting of the gypsum waste, magnetic separation for the removal of any metallic impurities like nails and screws, various comminution stages and subsequent classification and separation of other impurities. The quality requirements of the gypsum industry for recycled gypsum can be practically only met if the content of impurities in the delivered gypsum waste is at least lower than 5 %. Problematic are mineral impurities, as found when aerated concrete or screed is processed, while foreign substances such as paper, cardboard, plastics, timber and insulation materials can be removed comparatively easily on account of the difference in density to gypsum. In the case of gypsum fibreboard, the problem is that the paper fibres cannot be removed. If single-origin separation is possible, however, gypsum fibreboard can be comminuted and returned to fibreboard production [5].

New West Gypsum can be regarded as one of the pioneering companies in gypsum recycling. A first plant went into operation in Canada in 1985. Today, the company is represented with ten gypsum recycling plants (Fig. 15), not only in Canada, but in Belgium, Germany, England, France and Norway. The average quantity processed at one of these plants is 25 t/h or 0.1 Mta.



13 Overview of the gypsum recycling quantities



14 Overview of the gypsum recycling process [4]

More than 5 mill. t gypsum have so far been recycled by the company, the annual rate is just under 0.5 Mta. In Germany, Remondis is one of the leading companies in gypsum recycling. At its Zweibrücken site, a state-of-the-art plant (Fig. 16) with a capacity up to 72 000 tonnes material has gone into operation. 85 % of the input material is processed to recycled gypsum. Leftover materials like paper, plastic or metal are also recycled.

The leading companies in the recycling of gypsum plasterboard are the manufacturers of gypsum plaster board Knauf, Saint Gobain, and ETEX. Knauf took the top spot here in Great Britain and Scandinavia back in 2015. For example, in Denmark, a recycling rate of 17 % was achieved while in Norway a rate of 14 % could be reached. With its brand Siniat, which evolved from the takeover of Lafarge Plasterboard and comprises 35 plaster board factories, ETEX has set a new record in Great Britain. The percentage of recycled gypsum (RG) was increased to 18.4 % in 2020. For this, a quantity of 0.131 Mta gypsum was recycled in the plants at Bristol (Fig. 17) and Ferrybridge, UK. For 2025,

© NW Gypsum

15 Gypsum recycling in Great Britain

© Remondis

16 Gypsum recycling plant in Zweibrücken/Germany

a recycling rate of 30 % is planned at Siniat in England. Saint Gobain has shown especially through its subsidiary Gyproc that the recycling rates can be increased considerably if return and collection systems for plasterboard are introduced.

5 Technology developments

Whereas the technology for the recycling of gypsum waste can now be regarded as the state of the art, with regard to the processing or cleaning of phosphogypsum, that level is still a long way away. Phosphogypsum is a by-product in the production of fertilizer in the preparation of phosphoric acid from phosphate rock. The processes for the production of wet phosphoric acid production are differentiated based on the form of the precipitation of calcium sulphate as dihydrate, hemihydrate or anhydrite. For each tonne of phosphoric acid, depending on the process, between 4.5 and 5.5 t gypsum is formed. There are more than 200 different phosphate minerals. Most of the rock phosphates used are weakly radioactive and also contain impurities, which can concentrate in the gypsum product. Problematic are primarily the radionuclides radon-226 and lead-210 as well as high contents of residual phosphate.

There are various processes for the removal or neutralization of impurities in phosphogypsum. In Prayon's HDH process (Fig. 18), a high product yield of 98 – 99 % P_2O_5 and a good-quality gypsum is obtained from the outset. Moreover, Prayon also supplies downstream processes. First, these concern classifying of the gypsum, to remove the impurities that concentrate in the coarse grain, and second the washing and removal of soluble components such as residual phosphate, fluorine and sodium. Classification has proven to be a potential method for the reduction of the radon-226 content, as baryte, which is contained in the rock phosphate, enriches radon-226, tends to agglomerate and can be removed by screening. Positive results have also been returned by sorting processes by means of gamma spectroscopy, to remove material with excessively high radiological values.

IMPRINT

AT MINERAL PROCESSING WORLDWIDE

AT MINERAL PROCESSING
63nd Volume 2022
www.AT-minerals.com

bauverlag
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Publisher
Bauverlag BV GmbH,
Friedrich-Ebert-Straße 62
33330 Gütersloh/Germany
www.bauverlag.de

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Subscriptions can be ordered directly from the publisher, at www.bauverlag-shop.de or at any bookshop.
Bauverlag BV GmbH,
Friedrich-Ebert-Straße 62,
33330 Gütersloh/Germany

Subscription rates and period
AT MINERAL PROCESSING Worldwid is published with 5 issues per year.
Annual subscription (including postage):
Germany € 102,00
Other countries € 117,00
Single Issue € 29,00

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Druck/Printers
wentker Druck Gmbh, Gutenbergstr. 5-9,
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Audited by IVW German Audit Bureau of Circulations.

ISSN 1434-9302

H 7679

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17 Gypsum recycling at a gypsum plasterboard manufacturer

6 Outlook

The raw material gypsum is already scarce today and will in future become even scarcer,especially in countries and regions such as Europe, North America and Japan. But by the year 2030, supply should be secure. This is firstly because on a global scale the quantities of FGD gypsum remain largely unchanged, and reserves in the use of FGD gypsum still exist in Europe and the USA. In addition, in some cases, large quantities of FGD gypsum are stored in mono-landfills and can still be used for a relatively long time without any detriment to its quality. Besides FGD gypsum, there are still sufficient quantities of natural gypsum in many countries. The gypsum recycling rates can be increased considerably. Finally there are good possibilities for processing and recycling phosphogypsum, too. After 2030, the use of recycled gypsum and phosphogypsum will have a greater significance.

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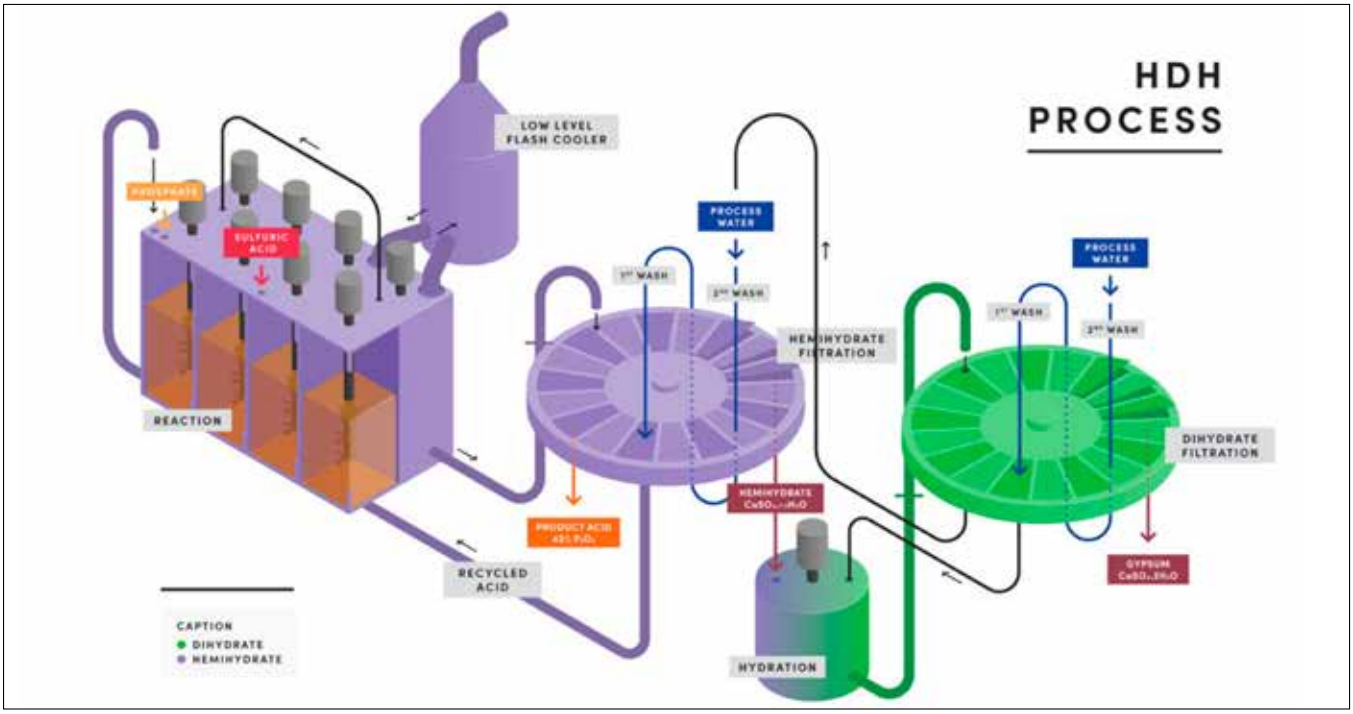

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18 HDH process for phosphoric acid production

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thyssenkrupp CK+

Circular-motion vibrating screen with many innovative features

With the introduction of the goovi®, the innovative multiple vibrating screen, thyssenkrupp Mining Technologies has set new standards in screening technology. The revolutionary drive concept of the goovi® is now being used in a simplified version for the proven circular-motion vibrating screens of the CK line. In combination with other interesting detail solutions, this new drive concept results in a more compact design, significantly reducing the number of rotating parts as well as the maintenance required.

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1 Circular-motion vibrating screen with dual motor drive on a mobile plant

For many years now, screens of the CK line have already been successfully used worldwide for screening of aggregates, gravel, ore and coal as well as in the recycling industry. They have impressed with their strong reliability and screening efficiency. With screening areas up to 17 m^2, in models with two or three screening decks, they are ideally tailored to meet the requirements of customers in the aggregates and mining industries. They can be integrated in stationary (**Fig. 2**), semi-mobile and mobile plants (**Fig. 1**).

1 Previous design

Circular-motion vibrating screens are of simple and rugged design. The sidewalls consist of standard steel sheets that can be laser-cut to any size and shape. Attachments and crossbeams are all bolted to the screen to maximize vibration resistance and lifetime. The screen tray is generally supported on steel springs, which stand on a steel structure.

The screen decks can be supplied in various versions with perforated plates, polyurethane surfaces or woven wire cloth or a combination of these, in line with customer requirements. The

2 Screening line with two thyssenkrupp CK circular-motion vibrating screens

screen linings can be changed easily and quickly with clamping and tensioning devices. In the feed area, the screens are fitted with a dummy floor to absorb impact forces. The screens of the CK line can be optionally fitted with a water-spraying system and/or dust cover.

The circular vibration is usually generated by shafts with unbalance discs fixed on both sides, the shaft bearings being integrated in the sidewalls of the screen. Depending on the size of the screen, one or two drive shafts are used, which are individually driven by a separate motor. For twin-shaft drives (**Fig. 1**), the two drives are synchronized by means of a toothed belt. The motors are mounted outside the screen tray on small platforms in the steel structure and are connected to the drive shafts by means of V-belts. To adapt screening performance and for optimum screen settings, the vibration amplitude can be adjusted by increasing or decreasing the unbalance weights. The speed can be varied just by changing the V-belt pulley.

2 CK+ innovative concept

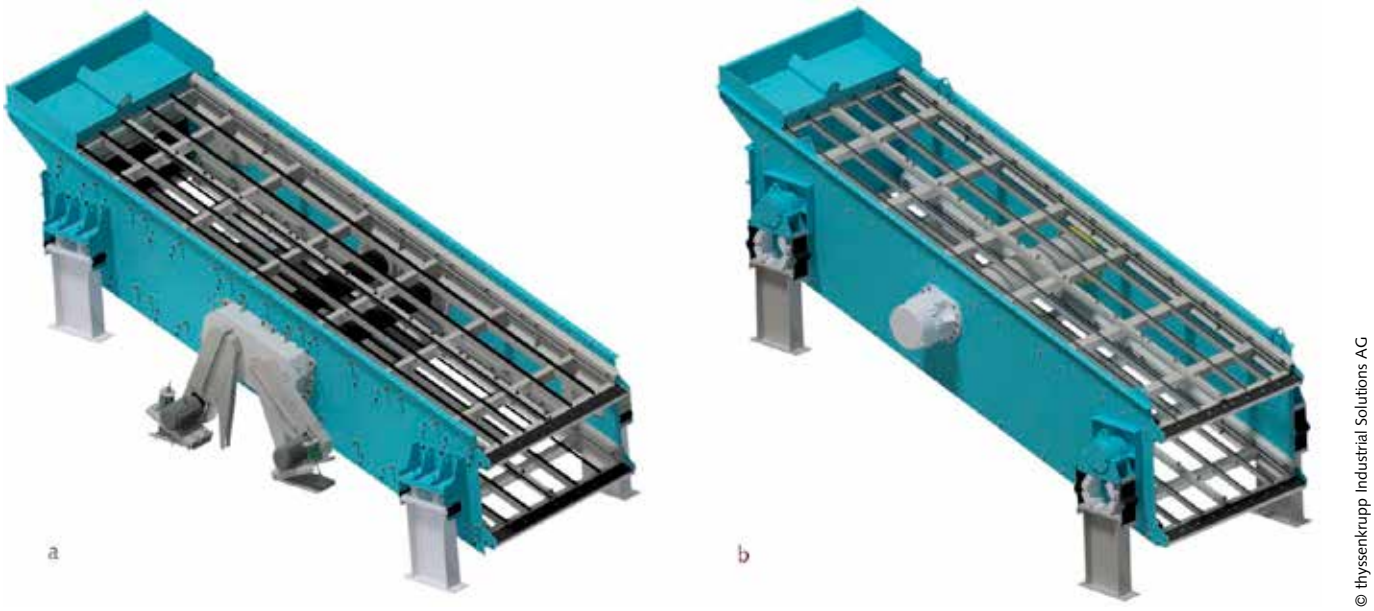
thyssenkrupp has now upgraded the existing CK line of circular-motion vibrating screens to the state of the art. Focuses of this development were the drive concept, support of the screens and easy maintenance. The new line has been designed to offer a substantial plus with regard to reducing production costs, installation effort and maintenance for the operators, so that logically the name CK+ was chosen.

2.1 Drive

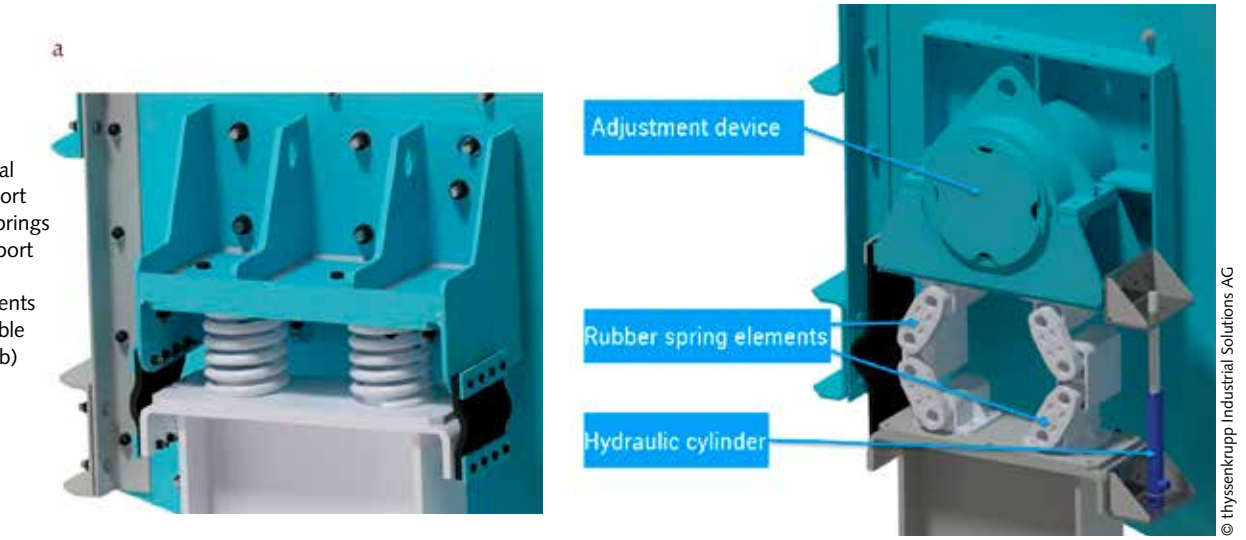
As mentioned earlier, conventional screen drives consist of diverse rotating and connecting parts, e.g. motors, V-belts, shafts and unbalance exciters (**Fig. 3a**). All these parts are subject to wear and must therefore be regularly maintained. Some of them must be anchored in the steel structure (motor), be safeguarded against manual interference (V-belts, toothed belts) or protected against wear caused by material falling down on them (shaft). A simplification of this system therefore offers interesting advantages with regard to installation, function and maintenance requirement.

The solution to this complex problem was already on hand at thyssenkrupp: in its newly developed goovi® screen, which has already been featured in several published reports, a novel, revolutionary drive concept has been introduced. This concept has now been transferred in a simplified form to the CK line of circular-motion vibrating screens. For this reason, compact, lifetime-lubricated standard unbalance motors are used, which are flanged symmetrically and directly to the sidewalls; these are synchronized by means of a connecting rod (**Fig. 3b**). This rod and the inner drive components are protected against falling screening material by a protective pipe with rubber coating.

The advantages of this compact solution with direct drive compared to a conventional drive are clearly shown in **Fig. 3**. The number of rotating and moving parts has been drastically cut, as a result of which maintenance requirement, failure probability and accordingly downtime are automatically reduced. Belt guards and motor platforms in the steel structure are not necessary at all with this concept. Accordingly, a lighter and less complex steel structure can be designed and the installation time is shortened significantly.



3 CK screen with conventional dual drive (a) and CK+ screen with flange-mounted direct drive (b)



4 Conventional screen support with steel springs (a) and support with rubber spring elements and adjustable inclination (b)

2.2 Support

In the design of the screen support, a completely new direction has been taken. Instead of the conventional screen support with steel springs (**Fig. 4a**), now rubber spring elements are used (**Fig. 4b**), which are supplied as standard components by speciality manufacturers. In comparison with steel springs, they offer very effective vibration dampening and low residual force transmission into the foundations. In addition, they boast a long lifetime, zero maintenance and low noise generation.

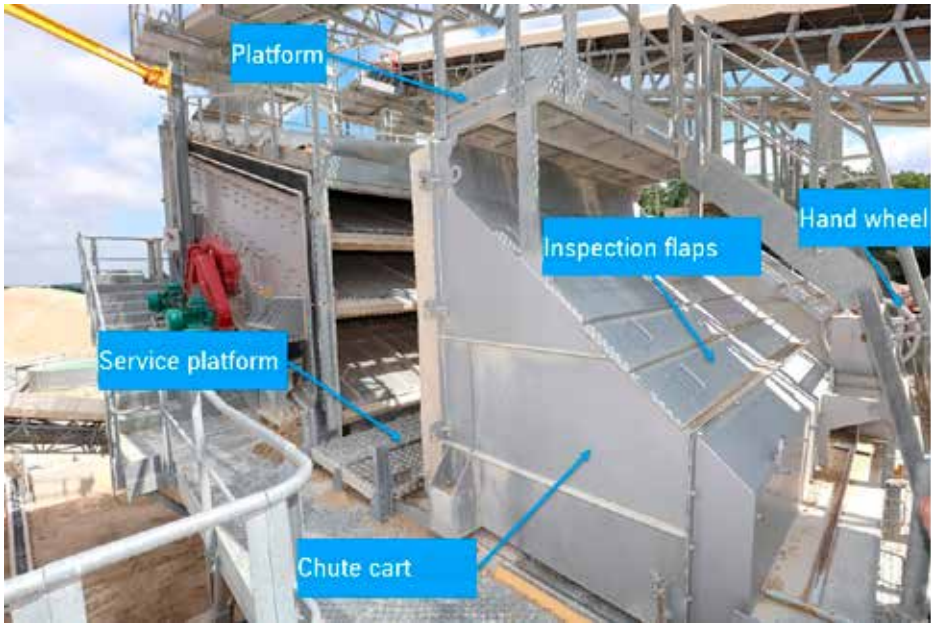
Another feature is the innovative adjustment mechanism that enables different settings for the screen inclination. Accordingly, the screen inclination can be adapted to the specific screening material and application so that optimum screening performance is ensured at all times.

For the fitting and removal of the rubber spring elements, the screen tray can be lifted by means of hydraulic cylinders so that the springs can be comfortably fitted under zero load.

2.3 Easy maintenance

A special feature of the new CK+ circular-motion vibrating screens from thyssenkrupp is their very easy maintenance. Of course, during reworking of the screen design, provision was made to meet the new stipulations in the recently revised EN 1009 with regard to the space requirement for maintenance work on machines for mechanical processing of minerals (**Fig. 6**). The distances between the screen decks and to the obstacles at different points have been increased considerably. The screen decks are therefore easily accessible and the screen linings can be quickly changed. For the fitting and removal of wear and replacement parts, no special tools are needed.

Another plus in respect of easy servicing is the optionally available mobile chute cart which diverts the material flows from the different screen decks on the discharge side in the desired directions to the downstream conveying elements (**Fig. 5**). During operation, it offers the possibility to control the function of the screen at any time by means of a platform and inspection flaps. For service work, the entire chute cart including platform can be moved back by means of a handwheel and a simple rail track. A movable service platform can be folded down over the space between screen and chute cart so that this area can be safely accessed. Now it is possible for the service workers to comfortably enter the area of the screen tray and to carry out any necessary maintenance work. Once servicing has been completed, the platform is folded back up and the chute cart moved back to the screen and locked into place. With this practical device, maintenance work can be performed safely and in a comfortable position with minimized effort to enable walk-on access.



5 Chute cart in service position

2.4 Sizes and possible applications

Particle sizes up to 200 mm can be fed to thyssenkrupp's new CK+ screens and screened at a minimum cut-point of around 1.5 mm. For this, a series with screening areas from 4–17 m² per screen deck is available, see **Table 1**. While the first two digits of the nomenclature specify the effective screening area, the number of screen decks is indicated by the last two digits. For example, a CK+ 1002 screen is a machine with a screening area of 10 m² and 2 screen decks.

As the connection dimensions are identical, CK screens of the previous generation can be easily replaced with CK+ screens with direct drive. This means that screen replacement can be carried out in the shortest possible time with extremely little effort.

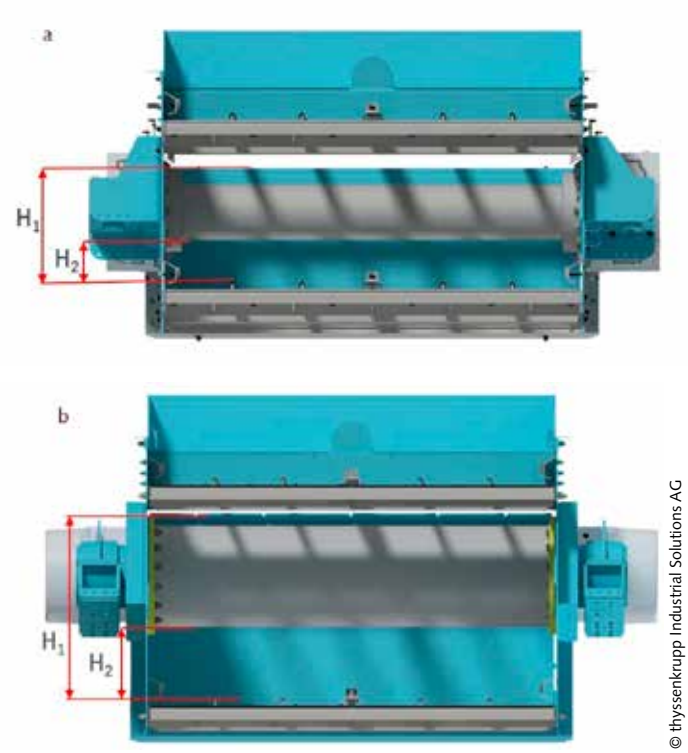
3 Summary

In comparison with conventional circular-motion vibrating screens, the new line of CK+ circular motion vibrating screens from thyssenkrupp Mining Technologies offers operators considerable advantages with regard to acquisition, installation and operation thanks to a host of innovative detail solutions.

Thanks to the compact drive with standard unbalance motors, many rotating and moving parts are no longer necessary. The same goes for all belt guards and motor platforms in the steel structure. This reduces the installation and maintenance requirements as well as machine failure and downtime, adding up to a significant cost saving both for screen acquisition and operation.

The screen support with rubber spring elements and an adjustment option for the inclination of the screen ensures quiet and safe operation and enables, thanks to adjustment of the screen inclination, optimization of the product quality.

Generous spacing between the screen decks in compliance with EN 1009 facilitates maintenance work in these areas so that screen linings can be changed quickly and safely. Access to the screening areas is enabled by a moveable chute cart and a fold-down service platform in a very short time.



6 Available heights for maintenance work between the screen decks in compliance with EN 1009 for the CK line (a) and the CK+ line (b)

Overall, the new CK+ circular motion vibrating screens from thyssenkrupp Mining Technologies impress with their compact design, high availability, low installation and maintenance requirement, and at the same time they enable very high throughput rates with excellent separation sharpness.

Size	Screen area (per deck) [m²]	Screen areas width x length [mm]	Number of screen decks	Number of drive shafts	Installed power [kW]	Total weight [kg]
CK+ 400	4	1,280 x 3,000	2 ; 3	1	2 x 3.6 – 2 x 5.8	2,300 – 2,800
CK+ 600	6	1,530 x 4,000	2 ; 3	1	2 x6,1	3,600 – 4,400
CK+ 800	8	1,650 x 5,000	2 ; 3	1	2 x 6,1 – 2 x 6,4	4,300 – 5,600
CK+ 1000	10.5	1,850 x 5,600	2 ; 3	1	2 x 6,4 – 2 x 12	5,800 – 8,200
CK+ 1200	12.5	2,110 x 6,000	2 ; 3	1	2 x 12 – 2 x13,9	7,500 – 10,100
CK+ 1400	14.5	2,410 x 6,000	2 ; 3	1	2 x 13,9	10,000 – 12,700
CK+ 1700	17.5	2,500 x 7,000	2 ; 3	1	2 x 13,9	13,400 – 16,600

Table 1: thyssenkrupp CK+ screen line

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Innovative Screening

Advantages and areas of application, comparative screening tests

Summary: The BIVITEC e+ combines two technologies developed by Binder+Co in one screening machine: the low dynamic loads due to mass balancing of the resonance screening machine and the flip flow system of the BIVITEC. This results in a lightweight design and low drive power. In the following report, the considerations for the development of a new type series are outlined, advantages and fields of application of the newly developed screening machines are explained, comparative screening tests are described, test results are presented, and several case studies are illustrated.

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BIVITEC e+

1 Introduction

In the 1980s, Binder+Co developed the type series of the BIVITEC flip flow screen for the classification of materials difficult to screen. These internationally known machines, which are used worldwide, have vibrating screen boxes which are braced by support springs on concrete or steel platforms and vibrated by means of unbalance exciters. Static and dynamic loads occur in the process, which place high demands on the support structure, especially in the case of larger machines, and result in corresponding costs. For more than 65 years, Binder+Co has also been manufacturing horizontally mounted resonance screening machines, which introduce relatively low dynamic loads into the environment by means of countervailing vibration of two screen decks of approximately equal mass. These machines are among the conventional screening machines with rigid screen decks and are supported on platforms via shear rubber blocks. The basic idea was to combine these two proven systems in a new type series of flip flow screening machines (BIVITEC e+) [1]. The overriding objective was to generate a high benefit for the operators of such screening machines from the resulting product characteristics, both in terms of investment costs and operating costs.

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1 Sectional view of a BIVITEC e+ single-deck machine

The first machines of this new type series were developed in 2019 and have a stationary screen box. Support via spring elements on the support structure is not required but can bring advantages in individual cases for further reduction of dynamic loads. Due to an almost perfect mass balancing of two oscillating masses S1 and S2 moving in opposite directions, only very low residual dynamic forces occur (Fig. 1). The oscillating masses are driven by an eccentric exciter and operated in the resonance range. Screen mats fixed between the respective crossmembers are alternately stretched and compressed, resulting in a whip effect which, combined with a screen deck inclination of approx. 15° to 25°, ensures material conveying and correspondingly sharp screening. Due to the low moving oscillating masses combined with the resonance principle, the new type series BIVITEC e+ in the single-deck version requires only approx. one third of the electrical energy for the drive motor compared to conventional BIVITEC screening machines. For large machine types, a weight reduction of up to 40 % can be achieved compared to a classic BIVITEC. The machine characteristic or operating frequency is almost infinitely adjustable or controllable by means of a frequency converter mounted on the motor and can be quickly and easily adapted to the particular material to be screened.

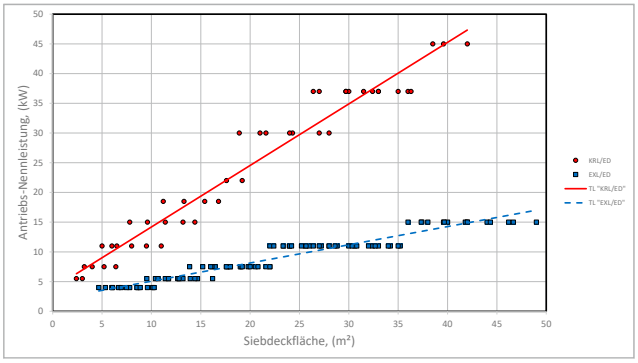
2 Advantages and application fields for BIVITEC e+

Depending on the task or project situation, the following advantages and areas of application are of particular importance:

- Low dynamic loads
- Low energy consumption
- Infinitely variable adjustability and controllability of the vibration characteristics
- Compact design
- Dust-retardant design easy to implement
- Screen deck areas from 1.2 m² to 49 m²
- Finest to medium separation cuts
- For stationary and mobile plants

An outstanding feature of the new type series concerns the very low required drive powers of the screening machines. To illustrate the resulting energy savings or the extremely low drive power ratings, the single-deck machines of the "KRL" type series ("classic" BIVITEC screening machines with "circular" basic vibration) will be compared with the machines of the new "EXL" type series (BIVITEC e+) in the following. The screening machine standard "KRL" comprises 45 single deck machines with screen deck widths from 0.8 m to 3.5 m and screen deck lengths from 3 m to 12 m. The screen deck widths indicate the respective internal dimensions available for the screening process (perforated screen mat area). The screen deck lengths indicate the distances from the first perforated to the last perforated screen mat of the screen decks considered. With the BIVITEC e+ (type designation "EXL"), even larger screen deck areas are possible due to the maximum standard screen deck length of 14 m. The "EXL standard matrix" contains 93 single deck machines with screen deck widths from 1 m to 3.5 m and screen deck lengths from 4.7 m to 14 m. The largest screen deck area per deck is thus 49 m² (3.5 m x 14 m), allowing a total screen deck area of 147 m² for a three-deck machine.

In Fig. 2, the nominal drive powers (kW) are assigned to the respective screen deck areas (m²). The total of 45 points – shown as "red filled" circles – identify the single deck machines of the "classic" KRL machines. In comparison, the machines from the new type series (BIVITEC e+ or EXL) were identified by 93 "blue-filled" squares. Looking at these two "point clouds", the considerably lower drive ratings of the screening machines of the new type series can be clearly seen. An associated trend line is shown for each of the two-point clouds or data series. The trend line shown as a "solid" straight line refers to the



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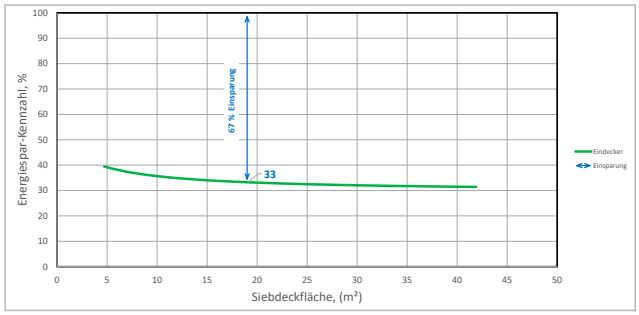
2 Comparison of drive power ratings

"classic" BIVITEC machines, the dashed straight line to the new BIVITEC e+ type series.

If these linear functions are put into relation, namely comparatively "EXL"/"KRL", the result is Fig. 3. This figure is intended to quantify the energy saving potential of the new type series. The comparable screen deck areas are in the range between 4.7 m² and 42 m². The functional values calculated in this way are referred to here as energy-saving ratios and given as percentages. Thus, the comparison of the single-deck machines yields an average energy-saving ratio of 33 %. This means that the installed nominal drive power of a screening machine of the new type series is on average only approx. 33 % compared to the installed nominal drive power of a machine of the classic type series with the same screening deck area. In other words, the use of the BIVITEC e+ can save about two thirds of the installed drive power of the single deck machines. From the function curve in Fig. 3 it can be seen that this type of savings potential tends to increase with larger screen deck areas.



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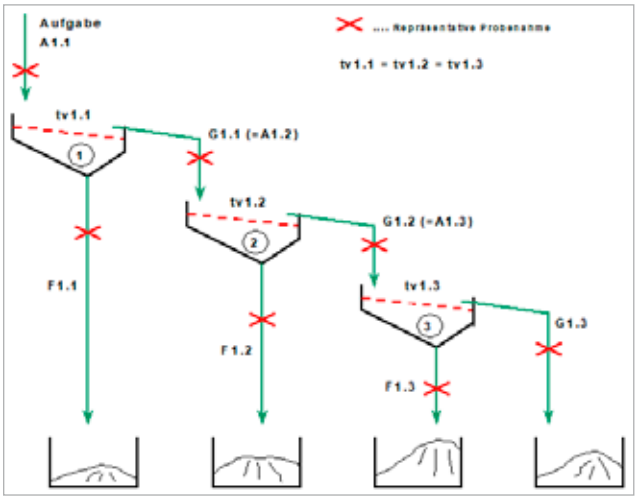
3 Quantification of savings potentials

3 Comparative sieving tests

3.1 Method of carrying out tests in the pilot plant at Binder+Co

For optimum screening machine design, tests are carried out with a pilot plant screening machine for the corresponding screen cut [2]. In a first step, the feed rate is determined using a calculation program programmed based on a factor method. The experimental machine has an effective usable screen length of maximum 2 m and is adjustable in inclination. A simple screening by feeding the screenings once and sampling the two product streams would in most cases not or only approximately correspond to a large-scale screening. In order to optimally design the required screen deck area for the respective task, the following procedure is followed: The feed quantity of about 1 m³ bulk material required for each test series is introduced into the screen feed hopper of the Binder+Co technical center in Gleisdorf. Considering the previously calculated screening time, the first test section is started and, after a constant operating condition has been reached, representative sampling of both screening products and the feed material is commenced. In each case, the entire stock stream is briefly collected several times with a sampling vessel. The composite samples obtained in this way are tapered by riffle or rotary dividers for the sample analysis provided later. The two product chutes direct the main quantities of screening products into the coarse product container and the fine product container. Similarly, the second test section is then carried out with the coarse product from the first test section. In this case, the screening plant is operated at a reduced feed rate so that the test duration of both sections is as equal as possible. Depending on the large-scale task, a third, fourth or fifth test section follows – if necessary – with as identical a duration as possible.



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4 Flow chart for the test execution with three test sections: A i.j feed, G i.j coarse material, F i.j fine material, tv i.j duration of the section, i number of the test series, j number of the test section

Fig. 4 shows a test series with three sections. To avoid misunderstandings, it should be noted that the screen shaker symbols shown in Fig. 4 with the numbers 1, 2 and 3 only identify the respective test section, but always refer to one and the same test machine (Fig. 5). After test execution and test evaluation, a correspondingly high specific feed rate results for the first test section, defined as the feed rate (in t/h) divided by the screen deck area provided (in m²). If the first two test sections are combined, G1.2 corresponds to the coarse material of the balance area. The particle size distribution of the fines is calculated from the compositions and product output values of the two fines products F1.1 and F1.2. The fines mass output is calculated as the sum of the two output values. Similarly, all three test sections can be summarized. The screen overflow G1.3 of the third test section is thus considered to be the coarse material of the entire balance area. With regard to the fines of the entire balance area, the three fines F1.1, F1.2 and F1.3 are combined by calculation, with the particle size distribution of this fines resulting from the compositions of the three fines and the mass output values. Compared to the specific feed rate at test section 1, the corresponding value when considering the combined sections 1 and 2 is about half, and about one-third for the combined sections 1, 2 and 3.

3.2 Comparative screen tests "BIVITEC – BIVITEC e+"

The feed material for the comparative screening tests consisted of 5 big bags with crushed limestone of nominal grain size 0/4 mm. Fig. 6 shows the corresponding particle size distributions in a diagram with logarithmically divided abscissa and double logarithmically divided ordinate. The data series D-01 to D-05 correspond to the test series V1 to V5 with regard to numbering.

The contents of big bag number 1 were accordingly used as feed material for test series V1 and fed to the "classic" test machine. This machine belongs to the LIL series with linear fundamental oscillation and can therefore be operated with a relatively low screen inclination. Test series V1 is to be regarded as the basic test

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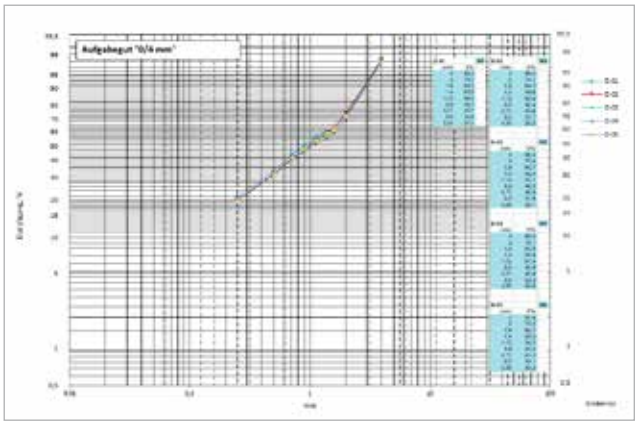
5 BIVITEC test machine with linear fundamental vibration in the pilot plant at Binder+Co

series. For all screen test series planned within this framework, three test sections each with six screen mats used were specified, which in turn corresponds to a total screen deck length of 6 m for each test series. Based on design calculations and preliminary tests, the target feed rate (t/h) for the basic test series was determined for test section1 and a screen deck inclination of 12°. At this point, two very important points should be mentioned: During the comparative screening tests, the objective was not to achieve the highest possible screening efficiencies or particularly low void contents in the products. The objective was rather to carry out a basic series of tests with a relatively high area-specific feed rate (tons per hour and square meter of screen surface area), whereby attention was to be paid to the best possible screen deck inclination with regard to separation efficiency.



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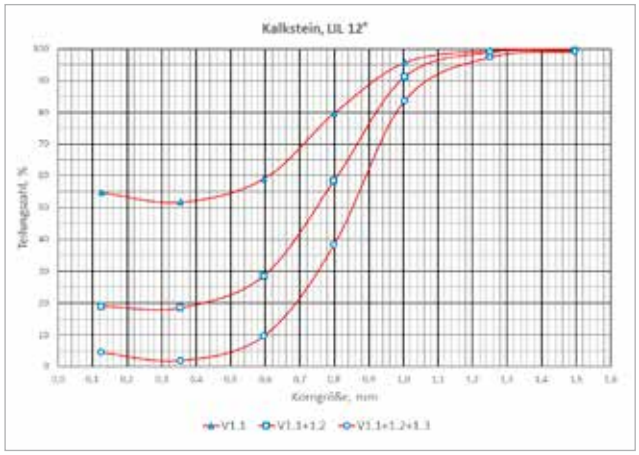
6 Representation of the particle size distributions of the feed materials for the comparative screening test series

Finally, the basic test series was carried out in accordance with the test procedure described in section 3.1. Punched plastic screen mats with perforations of 1 mm x 6 mm were used. For all test sections and test series, a nominal cut point of 0.8 mm is to be taken as the definition. The respective undersize contents in the screen overflow products are thus defined as contents < 0.8 mm and the respective oversize contents in the screen underflow products as contents > 0.8 mm. Concerning the vibration characteristics, precise measurements of vibration amplitudes and vibration frequency were carried out. The specific feed rate for test section 1 of test series 1 was 14.42 t/(m²h). The mass yield of the screen underflow was determined to be 21.2 % for this first test section. The undersize content (< 0.8 mm) in the screen overflow was 33.0 % and the oversize content (> 0.8 mm) in the screen underflow was 3.5 %. The undersize content, which appears very high at first glance, results from the fact that with the first test section, as it were, only the first two running meters of a 6 m long screen deck were simulated and confirms the well selected feed rate. After the second test section, the undersize content of the screen overflow was 17.3 % and after the third



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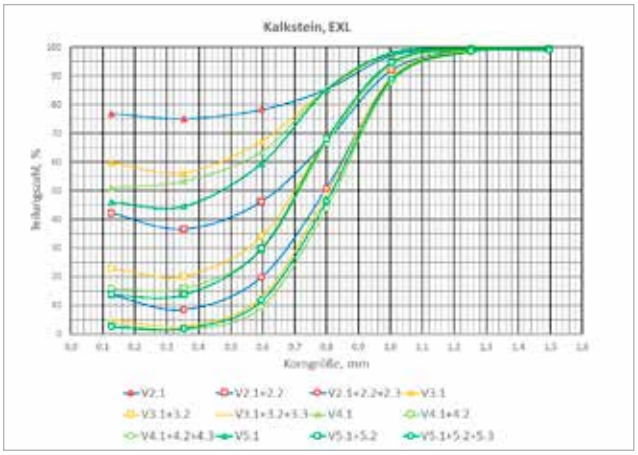
7 Representation of the coarse product-related partition curves for test series V1



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8 Representation of the coarse product-related partition curves for the test series V2 to V5: screen inclination angle 15° (V2), 18° (V3), 21° (V4) and 24° (V5)

section only 5.5 %. From the particle size distributions of the underflow products of sections 1 to 3 and the corresponding product mass yield values, an oversize content of 4.0 % could be calculated for "Section V1.1 + Section V1.2" and an oversize content of 6.0 % for "Section V1.1 + Section V1.2 + Section V1.3". In summary, for test series 1 – simulation of a screen deck with a length of 6 m – the mass yield of screen underflow is 46.5 %, screen overflow with an undersize content (< 0.8 mm) of 5.5 % and screen underflow with an oversize content (> 0.8 mm) of 6.0 %. These two contents of misplaced material confirm 0.8 mm as a well chosen value for the nominal cut point and confirm test series 1 as a very good basis for the subsequent, comparative test series with the new BIVITEC e+ test machine.

Fig. 7 shows the partition curves of test series 1. The ordinate values correspond to the coarse product-related partition numbers. The grain size is plotted as a characteristic on the abscissa. Seven test screens with mesh sizes from 1.6 mm to 0.25 mm and one test screen tray were used for the particle size analysis. This results in seven feature classes in each case. The coarsest characteristic class for the calculation of the coarse product-related partition number is grain size class 1.4/1.6 mm. This is followed by the grain size class 1.12/1.4 mm ... to 0.25/0.5 mm. For these grain size classes, the geometric mean values (square root of the product of the upper characteristic class limit and the lower characteristic class limit) were determined for the graphical representation of the partition numbers. For the entry of the graduation numbers for the finest grain size class 0/0.25 mm, the arithmetic mean (0.125 mm) is considered agreed.

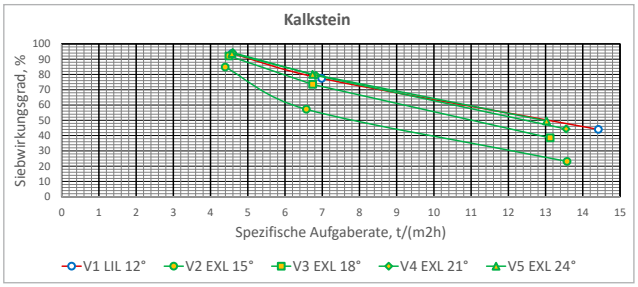
The upper partition curve describes the separation characteristic of test section V1.1. The ordinate values of the triangular symbols correspond to the coarse product-related partition numbers, the associated abscissa values refer to the respective particle size classes. Similarly, the points for the separation characteristics of "Section V1.1 + Section V1.2" (square symbols) and the points for "Section V1.1 + Section V1.2 + Section V1.3" (circle symbols) were drawn. In simplified terms, the upper curve here corresponds to the first two running meters of the screen deck, the middle curve to the first four running meters and the lower curve to the entire six running meters of the simulated screen deck. The steeper the partition curve, the higher the selectivity is to be considered. For further characterization, the parameters k50, k75 and k25 are defined. In the case of the screening processes considered here, these parameters are affected by the length dimension. The respective k50 value is the abscissa value to the partition number 50 % (cut point according to TROMP). The k75 and k25 values are the abscissa values to the partition numbers 75 % and 25 %, respectively. From the lower curve (V1.1+1.2+1.3) in **Fig. 7**, the cut point k50 = 0.851 mm can be read. The corresponding parameters k75 and k25 are 0.954 mm and 0.721 mm, respectively. A possible parameter with regard to comparison of separation characteristics is the imperfection, defined as (k75 – k25)/(2 k50). For the lower curve considered, the imperfection was 0.137. In simple terms, a low imperfection value means high separation efficiency. High imperfection values indicate low sharpness. If sections V1.1 and V1.2 are combined by calculation and the associated imperfection value is determined, the result is a comparatively higher value of 0.23 (simulated screen deck length only four linear meters).

The contents of Big Bag number 2 to Big Bag number 5 were available for the test series with the BIVITEC e+, and the associated test series were designated V2 to V5. In order to be able to exclude in particular the influence of possible manufacturing tolerances with the screen mats, the same set of screens was used for all of the total of 15 test sections, consisting of the same six BIVITEC screen mats in a fixed installation sequence. Accordingly, the screen mats of test series 1 were removed from the "classic" test machine and installed in the new BIVITEC e+ test machine for carrying out test series V2 to V5. In both types of screening machines, the dynamics of the screen mats have a significant influence on the separation characteristics. The setting parameters from the basic test series V1 described above were adopted and, if necessary, the oscillation amplitude was manually readjusted for the test series with the BIVITEC e+. In order to be able to exclude any influence due to different operation/sampling, the necessary activities (material loading, sampling, test observation, readjustment of the amplitude ...) were carried out by the same test personnel. A total of 35 aggregate samples were taken from the five test series. In order to obtain well-suited analysis sample quantities, the aggregate samples were appropriately tapered by means of riffle dividers. Reserve samples for any further analysis required were archived.

With regard to the avoidance of the influence of different measuring instruments, the same devices (vibration amplitude meter, balances, stopwatch ...) were used in all test series. Regarding particle size analyses, the same standardized procedure was always used with the same analysis screens by the same personnel.

Fig. 8 shows the separation functions of the four test series V2 to V5 with the BIVITEC e+. These four test series mainly differ in the preset screen deck inclination. In test series V2, the screen deck inclination was set to an angle of 15°. In each of the subsequent test series, the inclination angle was increased by 3°. The evaluation of the collected test data allowed a comparison of the selectivity in three respects. In a first step, the corresponding imperfection values were calculated as described above and shown in **Fig. 9** as a function of the respective specific feed rates. Due to the lack of fundamental oscillation in the BIVITEC e+, a correspondingly higher screen deck slope is required, as expected, to achieve high separation efficiency (test series V4 and test series V5). The screen deck inclination of 15° set for test series V2 is obviously too low to achieve high selectivity for this task. In comparison with the basic test series V1 (points shown as small blue circles, red curve), the separation efficiency of test series V4 and V5 is about the same or slightly higher (lower imperfection values). In a second step, the corresponding screening efficiencies were calculated and shown in **Fig. 10** as a function of the respective specific feed rates. The definition of the screening efficiency here is the fine particle discharge into the screen underflow, whereby particles with particle sizes smaller than the nominal separation cut (< 0.8 mm based on classical screen analysis) were defined as fines. Again, it can be seen that to achieve high separation efficiency for this task, the screen deck inclination of 15° set for test series V2 is obviously too low (see data series "V2 EXL 15°"). The results of the basic test series V1 are again shown as small blue circles or as a red curve. With the higher screen deck slopes of test series V4 and V5, one can again speak of practically the same selectivity. In the sense of a third approach, a key figure with the designation "Summed contents of misplaced material" is to be used. The "Summed contents of misplaced material" SFK is defined as oversize content of the fines + undersize content of the coarse product and can be expressed in percentage points (% pts). At this point, it should be pointed out again that the comparative screening tests were not aimed at achieving the highest possible separation efficiency (low SFK values). The main objective was to compare the new BIVITEC e+ machine type with the "classic" design in terms of selectivity, as well as to quantify the required (higher) screen deck slopes. The SFK values can be calculated both for the individual test sections, as well as for computationally combined test sections in each case, and for the individual test series. **Fig. 11** summarizes the evaluation results. The specific feed rate is again plotted on the abscissa. The small blue circles and the red curve indicate the basic test series V1. The relatively higher SFK values of test series 2 indicate, as expected, too low screen deck. In the case of test series V4 and V5, it is possible to speak of somewhat higher selectivity (relatively lower SFK values) compared to the basic test series V1. For example, in test series 4 (screen inclination 21°), the specific feed rate was 4.59 t/(m²h), the undersize content of the coarse product was 4.3 % and the oversize content of the fine product was 4.5 %. The associated SFK value is thus 8.8 % points. The evaluation of the basic test series V1 resulted in a worse SFK value of 11.5 %-points with approximately the same specific feed rate of 4.58 t/(m²h).

Fig. 12 summarizes the supplementary evaluation results graphically. The specific feed rate is plotted on the abscissa in the same way as in the three previous graphs. On the ordinate, the values of the respective cut points according to TROMP can be read off. The results for the screening tests with the BIVITEC e+ show relatively low cut points. This can be interpreted as follows: If the screen deck inclination is selected too low, a correspondingly lower separation efficiency is to be expected. The



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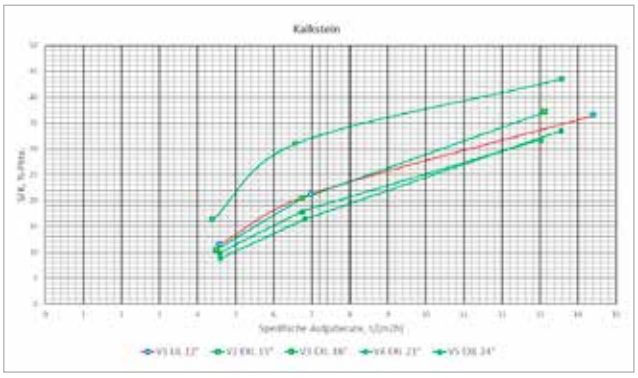
10 Representation of the screening efficiencies for the test series V1 to V5



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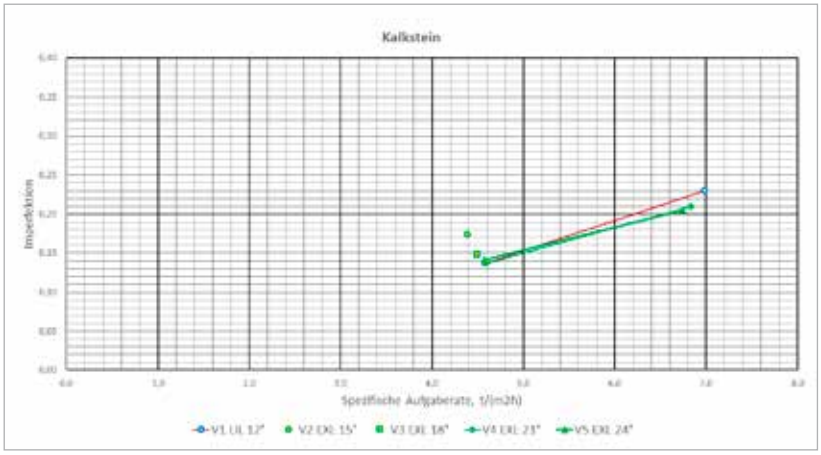
11 Separation efficiency representation based on the SFK key figure definition



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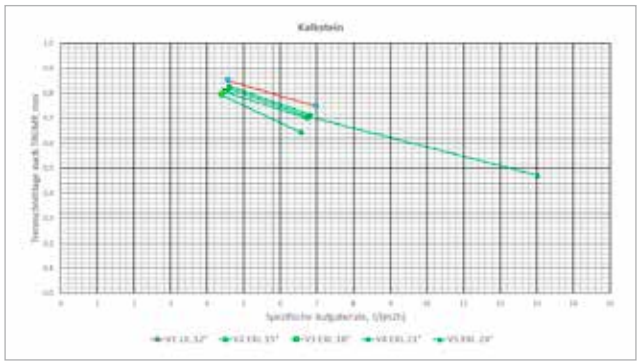
9 Representation of the imperfection values for the test series V1 to V5



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12 Cut point comparisons for test series V1 to V5

partition curves are flatter and lie correspondingly further to the left in the graph (see also **Fig. 8**). Lower k50 values are the result. At higher screen deck inclinations – which are necessary when using machines of the new BIVITEC e+ type series to achieve high separation efficiency – the "projected hole length" obviously plays a role. These "projected hole lengths" are correspondingly shorter at higher screen deck inclinations. The same hole sizes "act" like a slightly smaller hole length at higher screen deck inclinations. In practice, when using the BIVITEC e+, a short, slotted hole instead of a square hole can be provided at least in the feed side area of the screen deck, or a slightly longer slotted hole can be provided if slotted holes are generally specified. This shifts the separation cut to the somewhat coarser area according to TROMP. As an additional effect, a somewhat higher separation sharpness can be expected.

4 BIVITEC e+ case studies

As a first example, a screening machine for fines removal from crushed sands is shown. Shell limestone is screened in a processing plant in southern Germany. **Fig. 13a** shows the machine without side covers. The upper floating frame is part of vibrating system 1, the lower floating frame belongs to vibrating system 2 (see also chapter 1 and **Fig. 1**). A pre-screened crusher product of nominal particle size 0/2 mm with a relatively high filler content – defined as proportion < 0.063 mm – is fed onto the screen deck equipped with 20 slotted punching mats (**Fig. 13b**). The screen overflow 0/2 mm with low filler content (de-filled crushed sand) is the main product and is fed via the coarse material chute into a silo below. Since in this new type of screening machine the screen box itself has practically no oscillating motion, this chute could be bolted directly to the screening machine. The screen box is mounted on the fines chute, which guides the screen underflow into the fines silo directly below and is rigidly connected to it. The inclination of the deck is 17°. The screen deck width of 1.9 m and the screen deck length of 6.7 m result in a screen deck area of 12.7 m² and, at a feed rate of 40 t/h, a specific feed rate of 3.1 t/(m²h). The rated power of the drive motor is only 5.5 kW.

As a second case study, the screening of moist limestone is outlined. Approx. 65 t/h of crushed and pre-screened limestone of nominal grain size 0/16 mm are to be fed onto a double-deck BIVITEC screening machine. Each screen deck has an effective width of 1.3 m and an effective length – measured in each case from the first screen mat to the last screen mat – of 5.3 m. Practically two BIVITEC e+ single-deck machines bolted to each other are mounted one above the other (**Fig. 14**). The total nominal screening area is 13.8 m². The vibration characteristics can be infinitely adjusted separately for each screen deck and changed at the push of a button. Punching mats are used in the upper deck to realize the separation cut 8 mm. The punching mats of the lower deck allow the additional separation cut of 4 mm. This is followed by the three screening products 8/16 mm (overflow of the upper deck), 4/8 mm (overflow of the lower deck) and 0/4 mm (underflow of the lower deck). A drive motor with a nominal power of only 4 kW is installed for each screening deck.

In the third project example, a double-shaft log washer, a 2-cell attrition machine, a screw classifier, a classic linear vibrating

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13a BIVITEC e+ for fines removal from crushed sands

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13b Crushed sand at the screen deck

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14 BIVITEC e+, double deck design for screening moist limestone

screen, a double-deck BIVITEC flip flow screen in "banana" design and the first BIVITEC e+ with spraying system are planned as core components for a talc processing plant. The above machines were designed, engineered and manufactured at Binder+Co in Gleisdorf and delivered to Brazil. The BIVITEC e+ is used for the realization of the 0.25 mm separation cut in a rod mill circuit and is equipped with a special spray system (**Fig. 15**). As special features of this novel design can be mentioned:

- The spraying system is completely integrated into the stationary "BIVITEC e+ screen box". (Screening box "wet screening" is identical with screening box "dry screening")
- No additional headroom
- No protruding parts apart from the required water connection
- Spraying tubes can be dismantled individually for quick and easy screen mat change (quick coupling on one side in conveying direction on the right, optionally on the left)
- Rinsing tubes can be dosed or shut off individually
- Drain nipple on internal shower water distribution pipe
- Spray nozzles with variable nominal diameters (9 mm, 7 mm, 5 mm)

The inclination of the screen deck is 17°. The screen deck width of 1.9 m and the screen deck length of 6.7 m result in a screen deck area of 12.7 m². A crushing product of a wet-operated rod mill of nominal particle size 0/4 mm is fed. The feed slurry contains 15 t/h of solids. The screen overflow is returned to the rod mill, the fines slurry of nominal grain size 0/0.25 mm is product of the size recuduction circuit. The

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15 BIVITEC e+ with integrated spray system

16 Double deck design "2S", characterized by particularly low headroom

rated power of the drive motor of this screening machine is only 5.5 kW.

Fig. 16 shows a special design of a double-deck machine of the new type series in the production hall at Binder+Co in Gleisdorf. The two upper floating frames – one in the area of the right-hand screen cheek, one in the area of the left-hand screen cheek – are connected to the cross-members of both vibrating system 1 of the upper deck and vibrating system 1 of the lower deck to form a single unit (vibrating system 1). Similarly, the vibration system 2 is composed of the two lower floating frames, the cross members of vibration system 2 of the upper deck and the cross members of vibration system 2 of the lower deck. The vibration characteristic can again be continuously adjusted. In this design variant, however, it is the same for both screen decks and cannot be changed separately. In this project, the lower deck was decisive for the process engineering screening machine design. The upper deck is, as it were, somewhat oversized; the vibration characteristics can thus be optimized accordingly for the lower deck. The main advantage of this type of machine is the low overall height of the double-deck screen box. The screen box height of the type EXL/DD-2S 1900 x 6 described here is only 1437 mm. In comparison, a double-deck design with the type designation EXL/DD 1900 x 6 – practically consisting of two "stacked" single-deck machines – would have a total screen box height of 2056 mm. Another advantage of the EXL/DD-2S type is the reduced number of mechanical and electrical components. The screen deck width of 1.9 m and the screen deck length of 6 m result in a total screen deck area of 22.8 m². The installed nominal power is 11 kW. This machine has already been integrated into a plant for the preparation of shell limestone in 2021. A pre-screened nominal grain size 0/5.6 mm is fed, the upper deck handles the separation cut 2 mm (red screen mats), the lower deck is used for fines removal (screen mats in turquoise color). The overflow of the upper deck is called product 2/5.6 mm, the overflow of the lower deck is called product 0/2e (product 0/2 mm with correspondingly low content of fines < 0.063 mm). The underflow of the lower deck can be called filler product (fine by-product).

The fifth case study shown is a screening machine for screening limestone at a separation cut of 4 mm. The machine was originally intended for the IFAT 2020 (Trade Fair for Water, Sewage,

17 BIVITEC e+ as core component in a circuit with a vertical impact crusher

18a BIVITEC e+ with 35 m² screening deck area for screening wood chips

Waste and Raw Materials Management) in Munich as an exhibit at the Binder+Co stand. In 2021, the machine was integrated into a crusher circuit in Austria. **Fig. 17** shows the machine with the floating frame covers (upper cover in turquoise color scheme). The crushing product of a vertical impact crusher of nominal particle size 0/11 mm with a maximum particle size of 16 mm is fed onto the screen deck equipped with 14 slotted punching mats. The screen overflow passes through a coarse material chute flanged to the non-oscillating screen box onto a conveyor belt and is returned to the crusher as a recirculating stream. The underflow chute is also directly connected to the screening machine and the fines conveyor below it in a practically dust-tight manner, which transports the end product of nominal grain size 0/4 mm with an oversize content of < 10 % to free stockpile. Due to the extremely low dynamic load, the substructure could be designed accordingly light and cost-efficient. The inclination of the deck is 18°. The screen deck width of 1.6 m and the screen deck length of 4.7 m result in a screen deck area of 7.5 m². The rated power of the drive motor is only 4 kW.

By the end of 2021, 23 screening machines of the new type series BIVITEC e+ have already been sold. The screens are designed for different tasks for the processing of primary raw materials and secondary raw materials. As a final example of this article, a task from the wood processing industry is outlined. On the basis of several screening tests carried out in the Binder+Co pilot plant, it was possible to design a single-deck machine with a screening surface area of 35 m². The feed material is sawdust with particle sizes in the range 0/20 mm. The effective screen deck width of this machine is 3.5 m. The 30 screen mats are designed for a nominal separation cut of 3 mm and result in a screen deck length of 10 m. Two small electric motors with a rated power of 5.5 kW each serve as drive. **Fig. 18a** shows the machine in the assembly shop and **Fig. 18b** during loading in the open-air area at Binder+Co in Gleisdorf.

5 Outlook for BIVITEC e+, areas of application and additional functions of the "classic" BIVITEC

The machines of the new BIVITEC e+ series will be the clearly better choice for many projects, both in terms of investment and operating costs. However, there will also be many tasks in the future where "classic" BIVITEC screening machines will be used. As fields of application and additional functions of these "classic" machines the following list can be mentioned:

- Fine to coarse separation cuts (protective deck design possible)
- Half deck for additional cut points possible
- Conveyor floor for medium products or fines optionally possible
- "Banana" design (e.g. for high fines content)
- Lower screen deck inclination due to screen box basic vibration
- Higher feed rates

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18b Loading of the screening machine

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R. Todd Swinderman joined Martin Engineering in 1979 as an Engineer in Conveyor Products, and has served as V.P. and General Manager, President and CEO, as well as Chief Technology Officer and Technical Director. He holds more than 140 active patents in 12 different countries. In his work with CEMA (the Conveyor Equipment Manufacturers' Association) he has been instrumental in developing consistent standards to improve the safety and productivity of conveyor systems and components.

Fact or Fiction?

Conveyor "Rules of Thumb"

Summary: This article examines the need for training conveyor operators and maintenance personnel by discussing the many informal design axioms that have developed over the years, otherwise known as "rules of thumb". These rules have been developed by trial and error or from qualitative observations, often decades ago, and are routinely applied via specifications and by designers.

Conveyor with proper loading and tracking

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The topics picked for discussion – materials, skirtboards and tracking – will correlate to continuing problems in the handling of bulk materials by belt conveyor, often contributing to a lack of understanding and leading to addressing symptoms rather than root causes. Perhaps the only advice for conveyor design that has remained true is: Design for the worst-case conditions. But the reality is that often insufficient funding or engineering time is allocated to make the needed design changes to ensure safe and profitable operation.

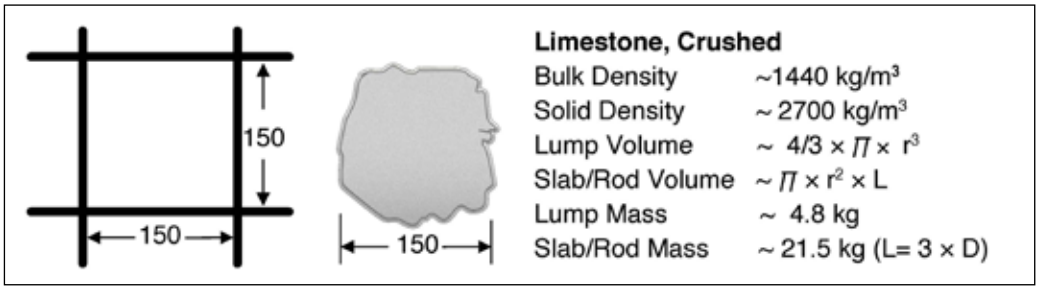
There are numerous design generalizations that are accepted as truisms and seemingly require no proof due to their long-standing use in conveyor fabrication and operation. This begs the question: If these rules are proven to address common problems, then why do we still have all the issues of chute plugging, belt damage, dust and spillage when operating bulk material handling conveyors?

The variances in recommendations indicate that it's easy to make mistakes unless the designer has solid, real-world knowledge in bulk material handling and can make educated assumptions when applying the rules. With the "old salts" who developed and handed down these rules long gone or fast retiring, there is a need to provide knowledge to the younger operators and maintenance personnel to avoid the trial and error associated with applying many of the handed-down design rules. Training based on a combination of industry experience and engineering will greatly improve design decisions, resulting in higher productivity, fewer safety incidents and reduced unplanned outages.

Historical design axioms

Many of these design principles undoubtably are the result of the early years of conveyor use and were developed by trial and error. Others emerged in codes developed in the early 20th century due to catastrophic equipment failures or as a result of being clearly correlated to injury risks or industrial disease outbreaks. Some had their engineering basis in testing done for early design manuals, but the original data has been lost. Yet the truisms live on. Then each industry and even each location developed their own rules, which became written into company specifications based on somewhat successfully treating symptoms rather than root causes.

There are often differences in rules by industry and many of them have no real engineering basis, instead being based on doing things the "same as before." Since the modern conveyor was developed in the early 1900s, much has changed in conveyor belt construction, capacities and regulations. Conveyors are still sources of pollution and accidents, so it seems clear that "same as before" just isn't good enough. The rules selected for discussion in table 1 are just a few of many common conveyor design guidelines that often contradict each other.

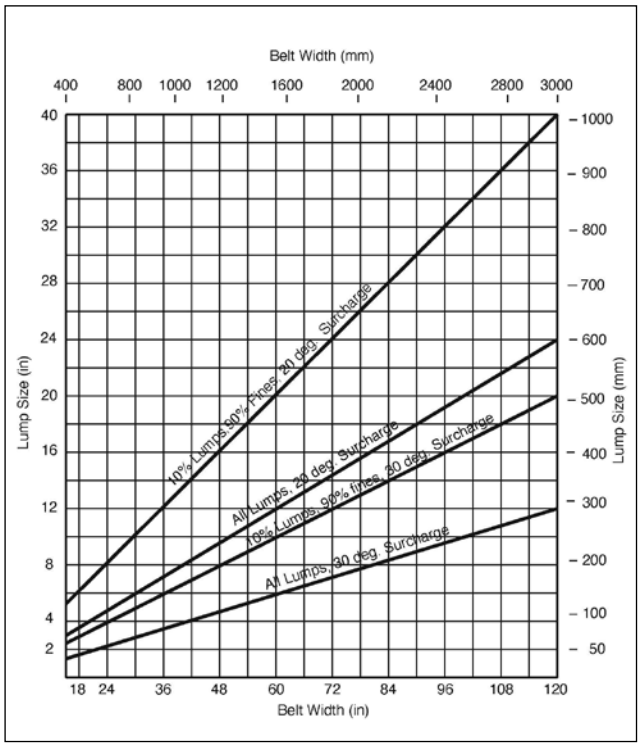


1 Lump and slab mass example calculation

Material size

As high concentration ore bodies are depleted, the remaining bulk material needs more processing to remove refuse and size the material for processing. The cost of raw materials also drives processors to accept lower grade materials with a higher percentages of fines. When the quantity, quality or sources of the bulk material change, the design must anticipate new handling challenges. It may be that "nominal lump size" is the biggest lie in bulk material handling, as the actual lump size in production is typically much larger than the design specification. This discrepancy in lump size from specified to actual is often due to adjusting crushers or screens to increase production, from gradual wear or from longer maintenance intervals.

The lump size and % of fines provide guidance on selecting the belt width and then the skirtboard width and height. In Table 1 the references state that the lump size is to be considered 2 to 3 times the nominal or specified lump size. The lump size also influences idler selection due to impact forces. Picking the maximum lump size also depends on how the material tends to fracture – into lumps or slabs. It may well be that a slab is much longer than 2 to 3 times the nominal size, while at the other extreme, lumps may tend to be more spherical. Understanding the material, its properties and behavior is critical not just for idler selection, but for many other considerations such as chute size and slope. Just because experience shows that on one conveyor limestone flows well on a 50 degree chute slope, for example, doesn't mean material from another pit or seam will flow down the same chute.



2 Lumps vs fines and belt width [6]

Bulk materials are hard enough to handle when consistent in size, physical properties and percent of fines. In Fig. 1, if the bulk density of 1440 kg/m³ is used rather than the solid or specific density of 2700 kg/m³, the mass used for idler and impact cradle selection would be almost 50 % underestimated, almost guaranteeing premature failures. For a slab or rod shape, the error could be significantly more than if using the nominal lump size. Lump or slab mass is a direct variable inputted into the idler and impact cradle selection methodologies. Correct maximum size and mass calculations can also affect belt selection. As the percentage of fines increases, the size of the lumps that can be tolerated on narrower belts also increases. In this example, 150 mm lumps and 10 % fines, for a material with a 30 degree surcharge, can be handled on a 900 mm belt, whereas if the cargo was 100 % lumps it would require a 1600 mm belt.

Skirtboards

Skirtboard width and length guidelines were developed long before dust was a concern, most likely developed by observation and experience to determine sufficient height to contain the turbulent material long enough to allow it to settle into a stable profile after the belt is loaded. When covers started being used to control dust, there likely weren't any changes to the height or length guidelines. Instead, the same general rules based on either belt width or belt speed continued to be used, expecting better results. Gradually it was recognized that the velocity of the air in the skirtboard enclosure had to be controlled to reduce dust emissions. At about the same time, suppliers and engineers began paying more attention to the wear liner and skirtboard sealing details to reduce leakage and spillage.

For the width of the skirtboards, most specifications follow the Conveyor Equipment Manufacturers Association (CEMA) recommendation of ⅔ of the belt width for most materials or ½ belt width for free-flowing materials, while the International Standards Organization (ISO) does not make a specific skirtboard width recommendation. CEMA and ISO have different free belt edge formulae for the distance between the loaded material profile and the edge of the belt. The free edge distance beyond the skirtboards is to prevent spillage outside the loading chute due to belt sag between carrying idlers. The free belt edge is often confused with the amount of belt edge necessary

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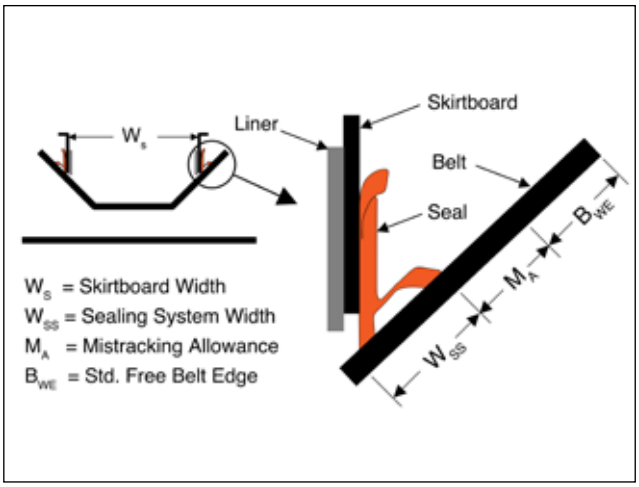
3 Dual skirt sealing shown with sufficient free belt edge can be flipped over when worn to double the service life

in the load zone for sealing systems and belt tracking. CEMA provides some guidance on skirtboard height based on lump size, but not for dust control.



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4 Inputs for belt sealing, mistracking and spillage for determining skirtboard width

Examining all the factors that go into an engineered loading of material on the belt would require a lengthy discussion of its own. The ⅔ of belt width rule is not generous enough on narrow belts and too generous on wider belts. ISO addresses the free belt edge with two formulae, one for belt widths under 2000 mm and one for wider belts. In addition to lump size, a main consideration for the skirtboard width is the space needed for the many different types of sealing systems, and to accommodate expected belt mistracking, because most belts mistrack far more than the commonly specified ± 25 mm allowance on a standard pulley face.

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5 Most belt tracking issues result from misalignment of the structure, pulleys and idlers

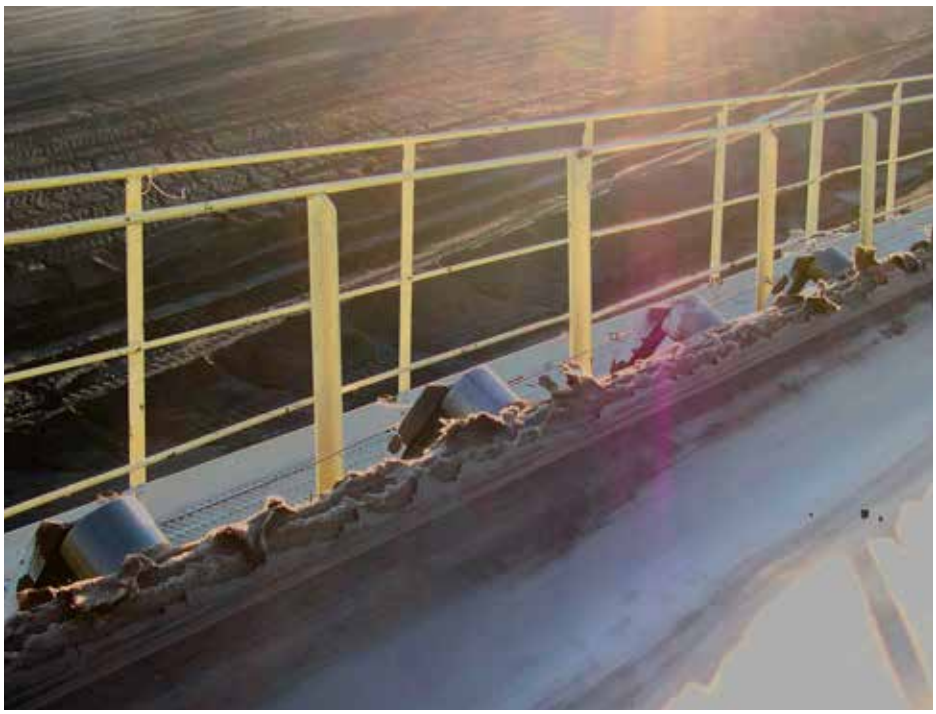
Category	Guiding axiom	Affects	Ref. #
Material size	Lump weight 2 to 3 times nominal material mass	Idler selection, impact force	1
	Maximum lump diagonal 2.5 times nominal for graded material and 3.0 times nominal for ungraded	Belt width, chute and skirtboard dimensions	2
Skirtboards	Skirtboard width 2/3 of the belt width, ½ of belt width for free-flowing materials	Side sealing, belt mistracking	1
	Skirtboard width 3 times the maximum lump size	Chute clogging, skirtboard dimensions, belt width	5
	Skirtboard extension 1.5 m + 0.6 m for every 1 m/s of belt speed	Skirtboard dimensions, spillage and leakage	3
	Skirtboard length 4 times belt width	Skirtboard dimensions	4
Tracking	Training idlers spaced from 31 to 46 m apart, and at least one training idler on conveyors less than 31 m long	Pulley face width, mistracking allowance, belt cleaning, spillage and leakage	1

Table 1: Common design rule examples

Fig. 4 illustrates that more than just the free belt edge must be accounted for in determining W_S, the skirtboard width. It is generally accepted that W_S is the inside dimension of the skirtboard uprights. If the wear liner is of significant thickness, such as cast iron or rubber blocks, the thickness of the wear liners should be considered in skirtboard spacing for their effect on conveyor capacity. Sealing system designs vary significantly, so the adequate edge distance in the load zone depends on the actual dimensions of the sealing system specified.

Belt Tracking

Theoretically, a properly installed and aligned conveyor system using a belt within manufacturing tolerances, with square splice(s) and center loaded should track without the need for training idlers. If most of the training idlers are tied off, it indicates that either they are ineffective or the belt must be constantly re-centered to compensate for structural and component misalignment or belt damage. Too many training idlers can interfere with each other and often make tracking worse. The guideline of installing training idlers a standard distance apart regardless of the quality of the installation and operation does not consider whether they are even needed or how much correction each training idler can generate. Sometimes more is less.



6 Belt edge damage from mistracking

If the belt doesn't have good contact with the training idlers (≥ 50 %), the poor contact can't create enough frictional correction forces to overcome the belt stiffness and move the belt toward the center. It's the same situation

7 Transfer point with enclosure, support, skirt sealing and dust curtains

when knocking idlers to try to track the belt. Over-adjustment for tracking causes bottom cover wear and consumes more energy than one might think. Training idlers cost more than standard idlers and may be adding unnecessary expense with little benefit.

For a start in locating training idlers, the most critical positions are before the belt enters the tail pulley, after the loading zone, before the belt discharges and before the belt enters the takeup. Portable and underground conveyors may require more training idlers because of the installation tolerances or distortion of the structural alignment when portable conveyors are moved. Most belt tracking problems are related to misalignment of the structure, pulleys and idlers, not the absence of enough training idlers.

Conclusion

There are many inputs required to make a safe and productive conveyor that are not included in the general design rules. Unless the personnel dealing with conveyor issues have a basic understanding of how to treat root causes rather than perpetuate temporary fixes, problems will almost certainly continue. With the retirement of many experienced operators and mechanics – and the difficulty in finding new workers – it becomes critical that new employees understand the basics of conveyor design and operation. The homegrown "we've always done it that way" solutions frequently treat only symptoms and not root causes.

Today, there are many options for non-commercial conveyor training. Many companies offer in-person classes or virtual training. Some firms use real-time video conferencing with cell phones to show the actual problems and discuss solutions "live" one-on-one. With the increased emphasis on dust control and safety, using these "same-as-before" rules probably isn't going to mitigate the dust emissions or provide adequate spillage control, resulting in workers' unnecessary increased exposure to respiratory disease or safety hazards from cleaning. The most effective approach to training examines a plant's specific conveyor challenges and helps operators run safer, cleaner and more productively by treating the root causes of its problems. The one axiom that still rings true: "If you think education is expensive, try lack of knowledge."

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