



Quality in sample preparation
for the cement industry

System solution for the cement industry



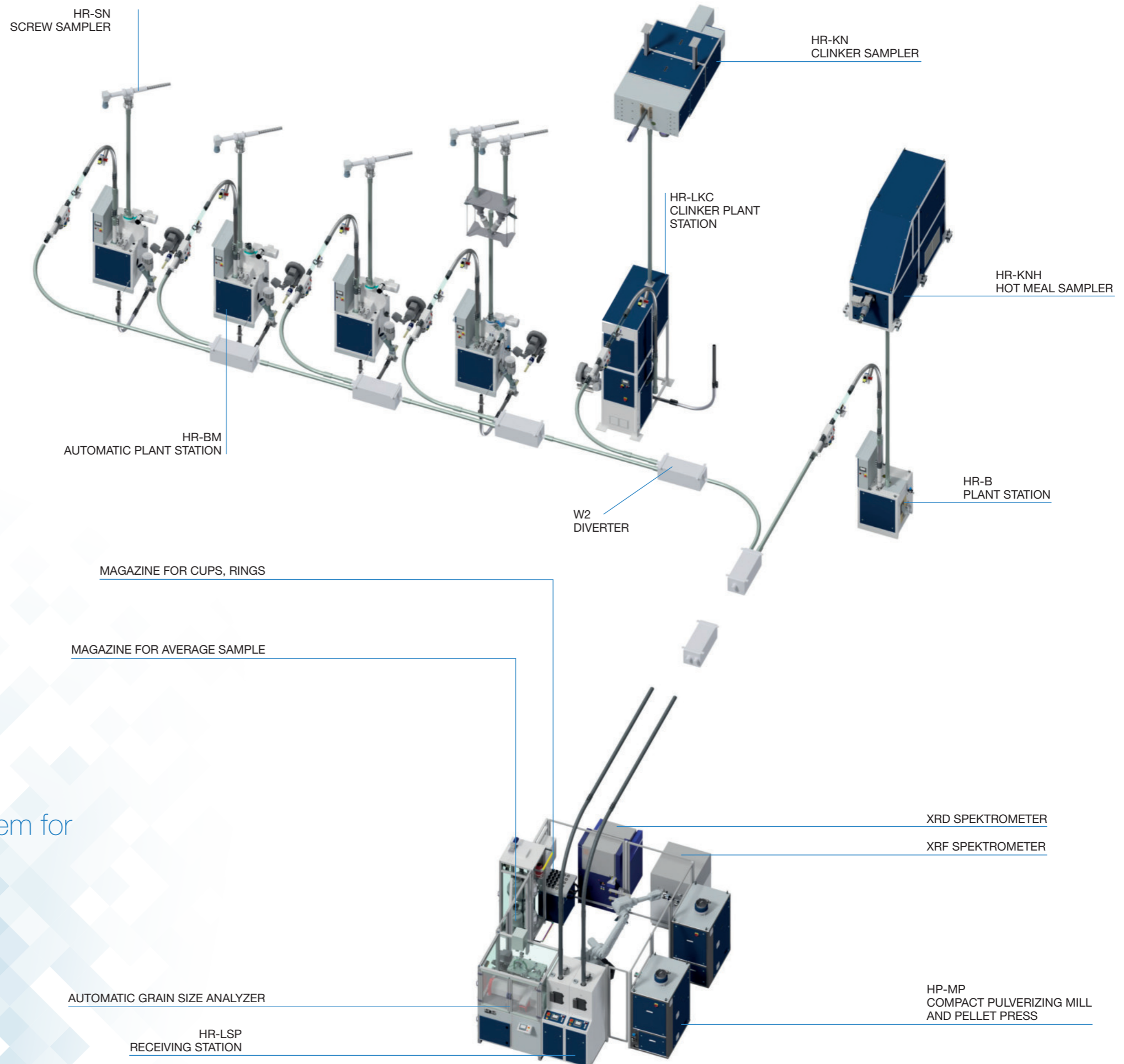
HERZOG is the leading partner of the cement industry in the set-up and engineering of laboratory systems. The increasing relevance of sustainable energy concepts, innovative production methods using a wide range of raw materials as well as the diversification of cement types lead to higher demands on modern laboratory systems. HERZOG Cement meets these demands with an exceptionally stable design concept, a machine portfolio tailored to the requirements of the cement industry, and an intelligent and integrative control and software concept.

The harsh conditions found in a cement production plant require the use of highly robust plant components. HERZOG machines are optimally adapted to high dust loads, abrasive material properties, extreme temperatures, and the other special conditions of cement production. Our samplers, plant stations and pneumatic tube components have been in operation worldwide, in some cases for decades, and require very little maintenance. HERZOG equipment therefore meets all the requirements for a high degree of both investment and process reliability.

HERZOG laboratory systems guarantee a reliable and comprehensive production monitoring from sampling to analysis and allow an easy adjustment of all system parameters. All relevant key performance indicators of analysis and automation are displayed and processed in such a way that they can be used efficiently for the control of the production process.

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Fully-automatic system for

- Sampling
- Sample transport
- Sample preparation
- Analysis

AUTOMATIC GRAIN SIZE ANALYZER

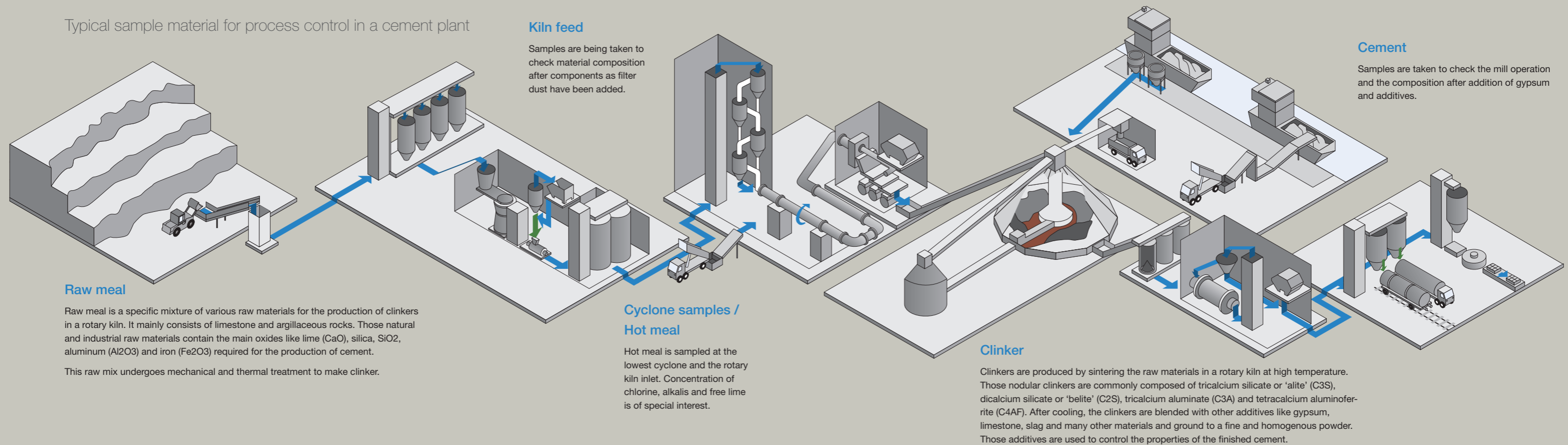
HR-LSP
RECEIVING STATION

XRD SPEKTROMETER

XRF SPEKTROMETER

HP-MP
COMPACT PULVERIZING MILL
AND PELLET PRESS

Typical sample material for process control in a cement plant



Sampling

The method and extent of sampling in the production process vary in each cement plant and depend on numerous factors such as variations in raw material quality and the operating mode of the production line.

HERZOG provides a wide portfolio of samplers which can be combined with different plant stations. This allows an optimal customization of the sampling equipment to the specific characteristics of each material in the production process. As a result, HERZOG machines meet all our customers' requirements for process reliability, stability, and representativeness.

Samplers are available as manual devices for collecting the sample material at site into a container. In this case, the operator has to take care of the sample transport into the laboratory.

Alternatively, in order to guarantee a reliable and quick sample transport, the samplers are connected to automatic sending stations. In this case, the sampling material is

automatically dosed into a carrier and transported into the laboratory via pneumatic tubes. Several sample increments can be collected and homogenized within a mixer upstream of the plant station. A representative and homogenized sample is taken from the mixer and transported to the laboratory. Subsequently, surplus waste material is returned to the system using the injector feeder system. Further-

more, mixer and plant station are automatically cleaned. The sampling protocol (sampling time, frequency and amount) of each sampling station can be easily adjusted using the Prepmaster software.

Screw Samplers for coal dust can be delivered as ATEX-certified equipment.



Screw sampler HR-SN



The HR-SN screw sampler is designed for the sampling of powder and fine-grain materials from vertical or inclined drop chutes.

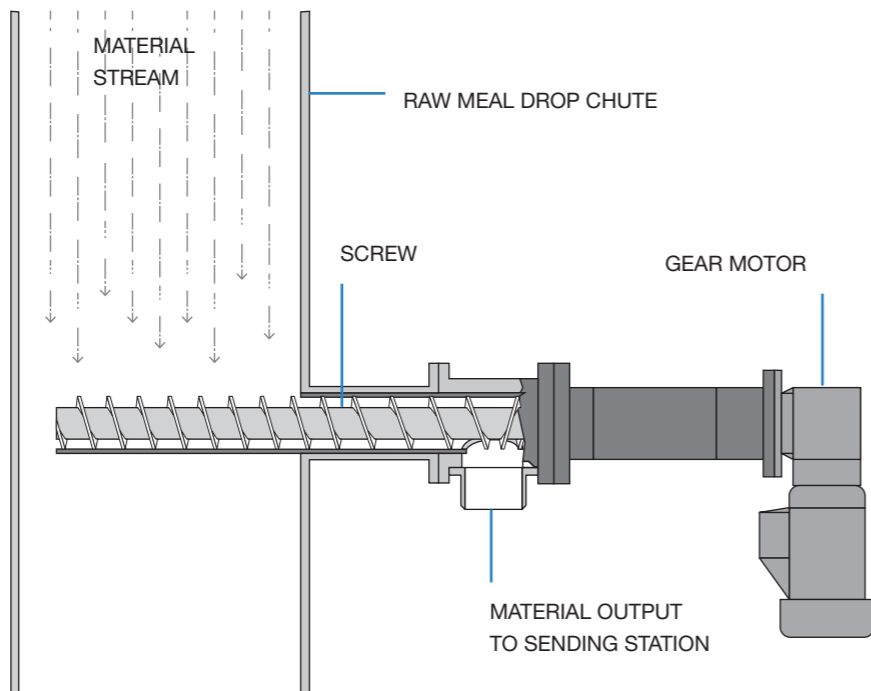
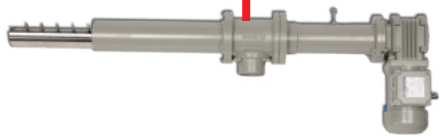
The semicircular-section trough of the sampler projects into the material flow with the open side facing upwards. The screw conveyor transports the sample material via a downcomer directly into the downstream process station. The sampling cycle is controlled by the controller of the plant station.

Main features:

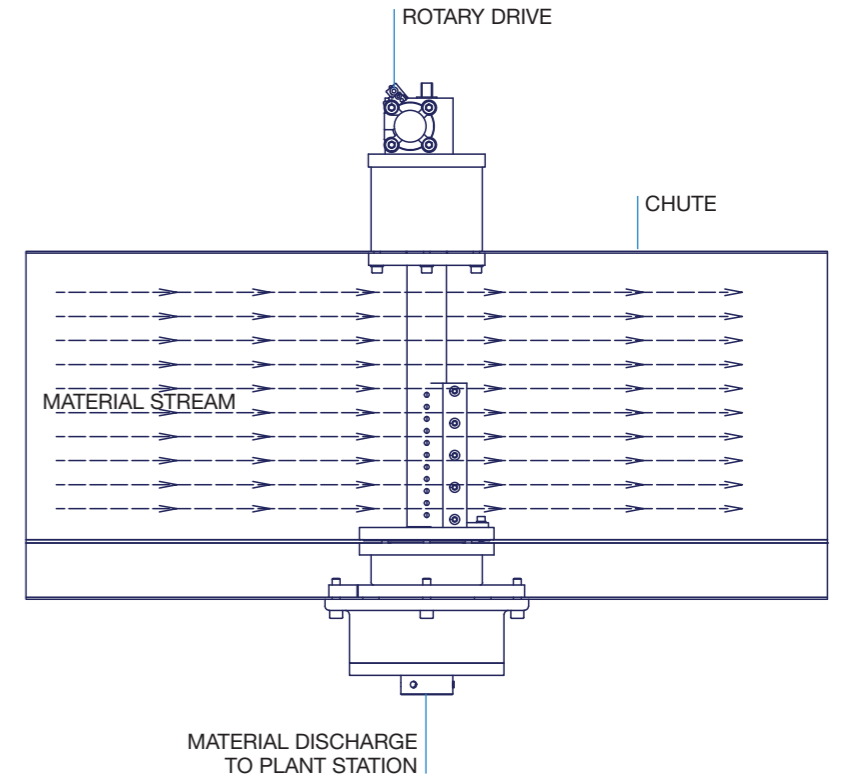
- Screw length according to application between 240–1500 mm
- Capacity approx. 2.3 l/min
- Built-in places: Horizontal in vertical or inclined drop chutes
- Maximum sample grain size 200 µm



Installed Screw Sampler



Installation on site



Airslide sampler HR-RN

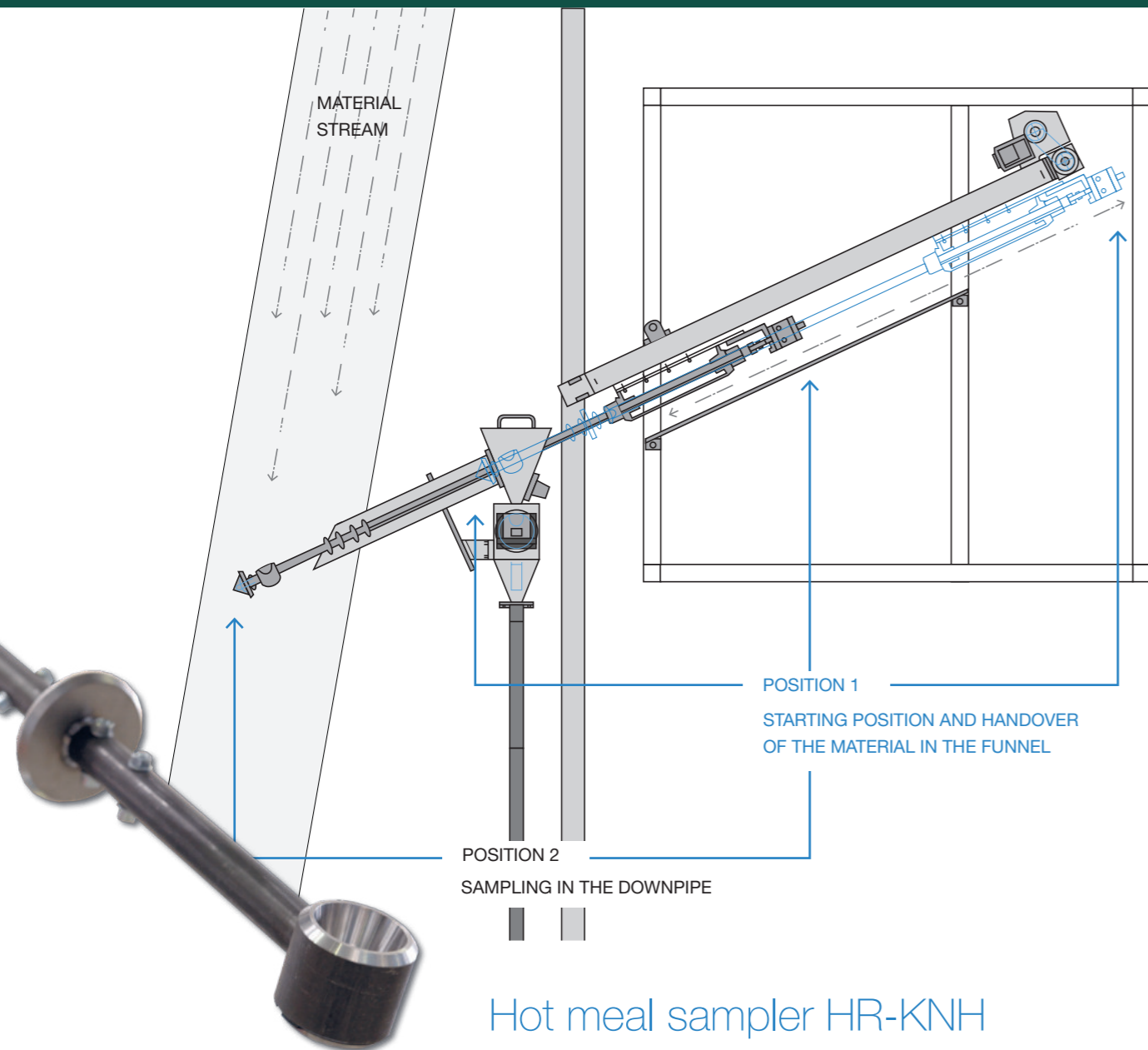
The HR-RN air slide sampler is designed for the sampling of powder and fine-grain materials from horizontal air conveyor troughs.

A perforated collecting tube located vertically in the air conveyor trough retrieves the sample from the material flow. The perforations in the collecting tube are rotated into the material flow for the purpose of sampling. In the closed condition, the holes are turned in the opposite direction. The collecting tube is driven pneumatically. Once retrieved, the sample can be transported through a downcomer directly into a downstream process station. The sampling cycle is controlled by the controller of the plant station.

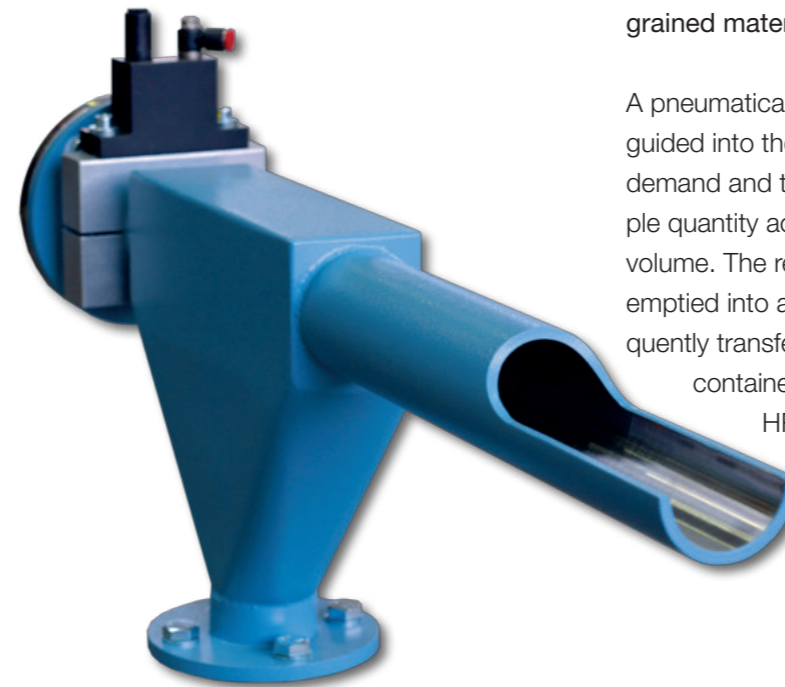
Main features:

- Pneumatic rotary cylinder
- Continuous sampling from horizontal processes
- Sample volume approx. 40 ccm per 5 sec.





Piston sampler HR-PN



The HR-PN piston sampler is suitable for sampling powdery and fine-grained materials from vertical or inclined drop chutes.

A pneumatically actuated piston is guided into the material stream on demand and takes a specific sample quantity according to the piston volume. The removed sample is emptied into a funnel and subsequently transferred to a collecting container or to the HR-B/HR-BM plant station for fully automatic transport to the laboratory.

Main features:

- Housing with output hopper and connecting flange
- Sample volume approx. 50-160 ccm³
- Maximum sample grain size 200 µm
- Maximum sample temperature 200 °C
- Optional ATEX version

Hot meal sampler HR-KNH

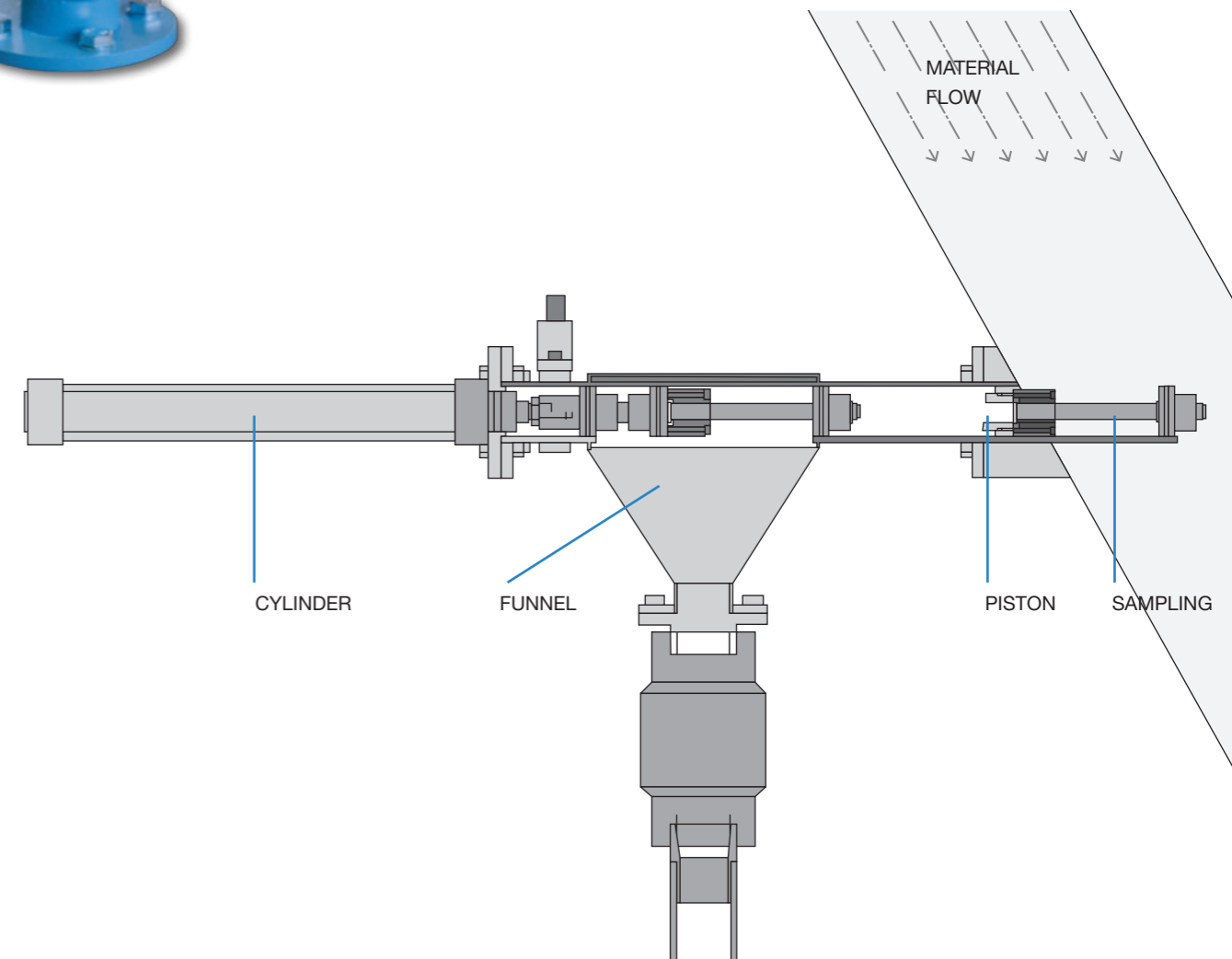
The HR-KNH sampler is suitable for sampling hot, powdery, and fine-grained materials from vertical or inclined conveyor shafts.

The lance of this special sampler is advanced into the shaft by means of a hydraulic drive. The high force density and dynamics of the hydraulic drive make it possible to push through solidifications and adhesions of the hot powder at the edge of the shaft. The sample material, which is up to 900°C hot, is quickly cooled down to below 40°C on a water-cooled transport chute. The material can then be sent to the laboratory via an HR-B type plant station.

The HR-KNH can be moved and freely positioned at the sampling point. This greatly facilitates commissioning and maintenance of the machine, e.g., during a plant shutdown.

Main features:

- Sample lance with bucket and a hydraulic drive
- Cooling system with blower
- Maximum sample grain size 200 µm
- Maximum sample temperature 900° C



Clinker sampler HR-KN



Clinker sampler HR-KN type 1

Type 1 represents the larger model and can be installed especially at hot shafts directly after the kiln. The HR-KN Type 1 is very resistant to impacts of larger lumps on the lance during sampling. The sample lance has a volume of approx. 1 l and can hold a grain size of up to 80 mm. An integrated sieve with a mesh size of 25 or 40 mm can be used to fractionate the sample.

Main features:

- Sample volume 1 l, max. grain size 80 mm.
- Integrated sieve
- Maximum sample temperature: 400° C
- Hydraulic drive
- Reach of the lance in the shaft approx. 820 mm



Clinker sampler HR-KN type 2

Type 2 represents the smaller model and is used for sampling of cooled clinker. Due to the narrow design, the sampler is also suitable for smaller shafts or narrow spaces. The sample lance has a volume of approx. 1 l and can take grain sizes up to 80 mm. However, since no sieve is built into the sampler, it is important to ensure that the downstream crusher can comminute the accumulating grain sizes.

Main features:

- Sample volume 1 l, max. grain size 80 mm.
- No integrated sieve
- Maximum sample temperature: 400° C
- Hydraulic drive
- Reach of the lance in the shaft approx. 500 mm



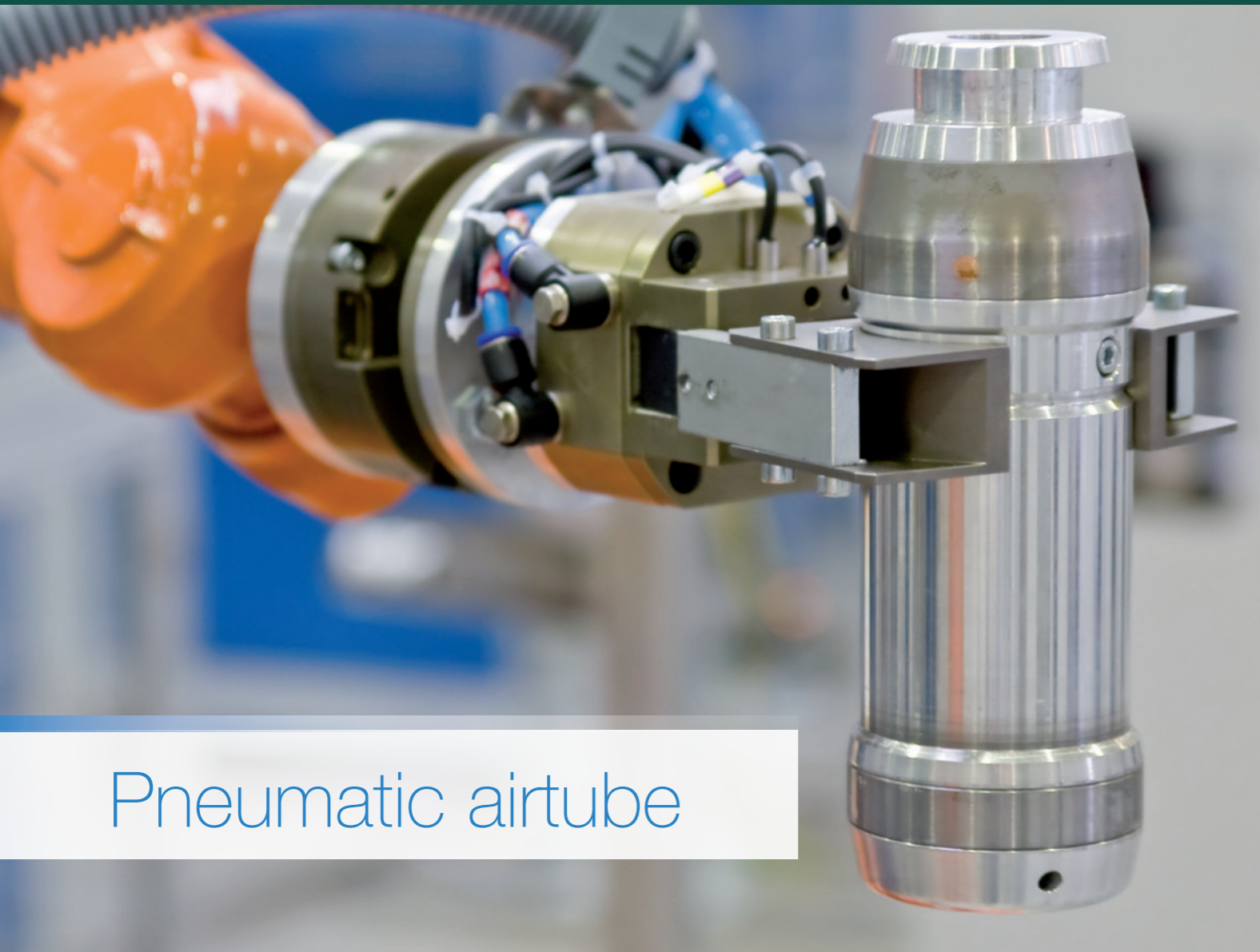
Clinker sampler HR-KN type 3

The clinker sampler type 3 has a shovel at the end of the sample lance. This makes it possible to take a larger sample quantity up to a volume of 10 l. In addition, the bucket is wider than the sample lances of type 1 and 2, so that a larger cross-section can be taken from the flow. This is an important basis for a high representativeness of the sample.

A horizontal sieve can be connected below the sampler to ensure that only a specific grain size fraction is further processed. The unused oversize material is returned to the production process.

Main features:

- Sample volume up to 10 l, max. grain size xx mm.
- Maximum sample temperature: 400° C
- Hydraulic drive
- Reach of the lance in the shaft approx. 1100 mm
- Optional connection of a horizontal sieve



Pneumatic airtube

The HERZOG pneumatic airtube system provides a reliable connection between the sampling stations in the plant area and the laboratory. Sampler, plant and laboratory stations as well as all pneumatic tube components and control elements are specially designed for the requirements of the cement industry and optimally matched to each other. This allows an efficient pre-preparation of the sample already in the plant (crushing, splitting), a delay-free transport to the laboratory as well as a contamination-free sample handling.

The HERZOG pneumatic airtube system offers a high degree of flexibility. The plant stations are designed in such a way that installation is possible even under narrow spatial conditions. In case of proximity to the sampler, the sample is usually fed into the plant station by gravity. At a greater distance from the sampler, sample feeding can be actively performed by means of transport screws or a vacuum conveying system.

Reception of the sample carriers in the laboratory is realized with the laboratory stations HR-LSP or HR-LA. The carriers are directed from the plant stations to the laboratory stations by means of diverters. The combination of two-position, three-position, and cross diverters as well as the HERZOG control concept enables a high degree of flexibility, efficiency, and speed in the carrier transportation.

The integrated dosing system in the laboratory stations allows volumetric measurement of several subsamples for different analytical methods. The generation of cross-sectional average samples from individual samples is also possible in the laboratory station.

Plant station HR-B / HR-BM

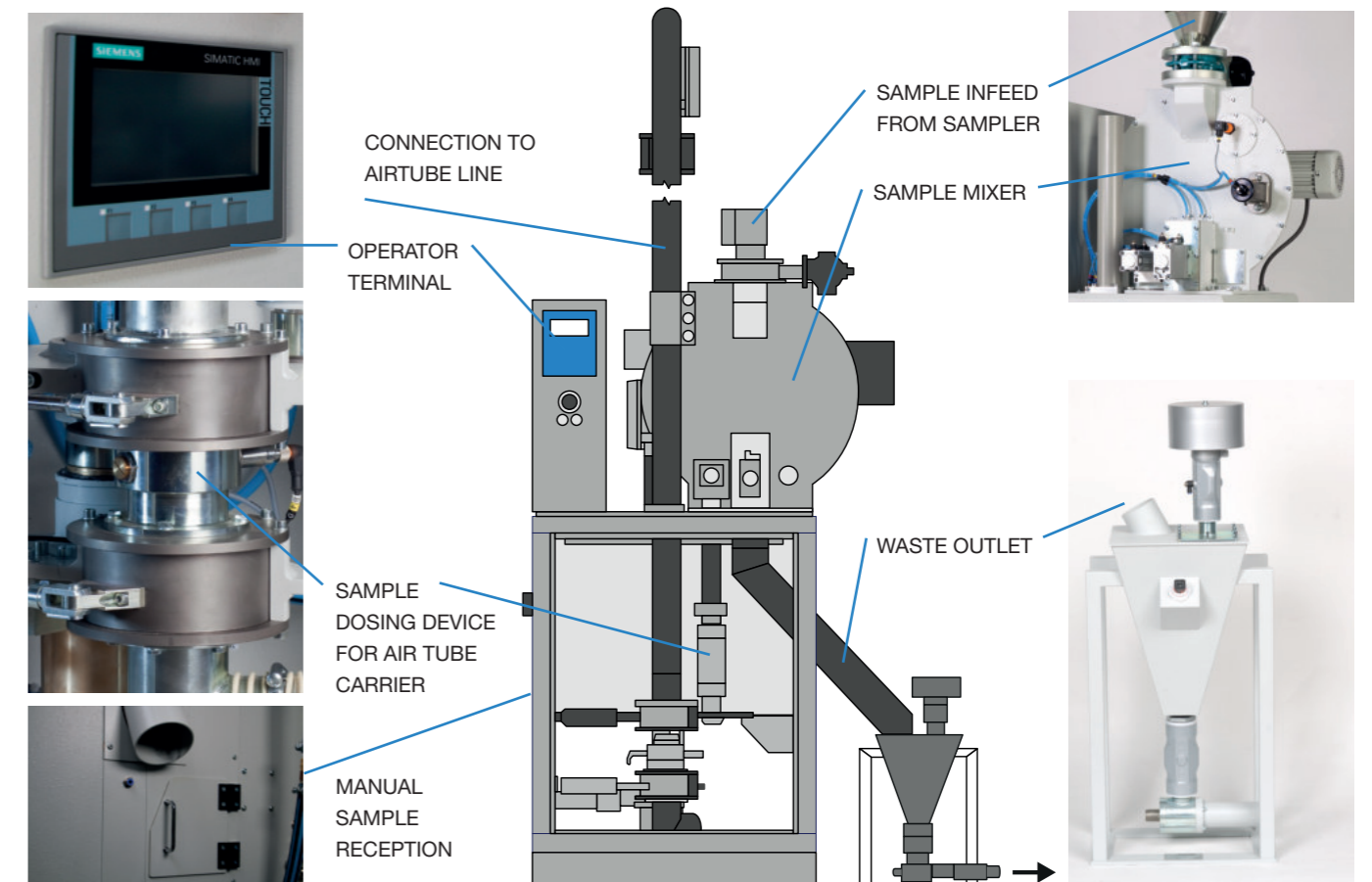
The HR-B plant station is suitable for sending different sample materials from the cement plant to the laboratory. The HR-B/ HR-BM can be connected to different samplers, doses the required amount of material into the pneumatic carrier and sends the sample to the laboratory fully automatically. If it is not possible to feed the sample from the sampler to the plant station by gravity, the material can also be transported by a vacuum conveying system. If sending the sample to the laboratory is not possible or desired, the collected sample can also be dispensed into a cup and easily removed via a door in the machine.

The HR-BM is additionally equipped with a mixer with a volume of 15 l, which collects individual spot samples, homogenizes them, and dispenses them into the dosing device on demand. This allows the preparation of average samples over a longer period. This can help to improve the representativeness of the sample being sent to the laboratory. The mixer is optionally available in a particularly resistant material grade, so that abrasive materials such as clinker can also be handled.

After the sample has been sent, the residual material that is no longer required can be transported back into the production stream via a sample return system (HR-FRG) and the next cycle can then be started.



Sending Station with Sample Mixer



Plant station for clinker HR-LKC



different configuration options of the HR-LKC

HERZOG offers a variety of different solutions for the processing of clinker samples in the plant. The standard HR-LKC plant station is suitable for clinker samples up to 25 mm and includes a mortar crusher with upstream vibrating chute, a splitter, a sample dosing, and a unit for sending and receiving pneumatic carriers. Hot samples can be cooled down with a special cooling device. In addition, a sample return system type HR- FRG can be integrated into the clinker station.

For clinker sizes up to 90 mm, a jaw crusher can be built into the HR-LKC instead of the mortar. If only small sample volumes are taken, a vibrating chute for spreading out the material as well as a sample splitter can be omitted. In this case, the small version of the HR-LKC with integrated mortar crusher and sending and receiving unit is an option.

If necessary, the system can be adapted to the situation of limited installation space. For example, the crusher and splitter can be housed in an own separate casing, while material dosing and pneumatic carrier handling take place in the HR-B or HR-BM. The HR-B/ HR-BM can also be positioned at a further distance from the crusher/splitter. In this case, the material is transported to the plant station by means of a vacuum conveying system.



LSP with door for manual sample reception

Laboratory Station HR-LSP

The HR-LSP is a fully automatic laboratory station for receiving granulate and powder samples and returning the emptied carrier to the plant. The emptying of the pneumatic carrier as well as the dosing of the material takes place within the machine, without the carrier having to leave the HR-LSP. This results in short handling times and fast readiness of the machine for the next sample. The sample material discharged in a sample cup is transported further via a robot or conveyor belts. For robot operation, the rear of the station is open, allowing direct access to the cup. By means of compressed air cleaning and further measures such as sliding coatings or vibration technology, residual material build-up and contamination within the machine are prevented.

Laboratory station HR-LA

The HR-LA is a fully automatic laboratory station which can be connected to a mill/press combination HP-MP or other sample preparation machines by a belt connection. In the HR-LA the carrier is opened and the sample material is discharged into the dosing device, which dispenses the material into a sample cup. After the carrier has been returned to the plant station, the machine is ready to receive the next sample.

Optionally, the HR-LA can be equipped with an integrated average sample magazine. Up to 10 average samples can be collected for different sample classes. In addition, samples can also be manually entered by the operator via an optional magazine and subsequently prepared and analyzed in the automation system.





Sample preparation

Accurate, precise, and fast analysis of production samples plays an increasingly important role in controlling production processes in the cement industry. Factors such as the increasing use of secondary fuels or greater fluctuations in raw meal composition lead to higher demands on the performance of cement laboratories.



Sample preparation machines and laboratory systems from HERZOG are perfectly adapted to the quality control requirements of modern cement production. They offer optimal sample preparation for X-ray fluorescence analysis and diffractometry as well as other methods such as combustion analysis, granulometry and colorimetry. A central step in sample preparation is the production of pressed tablets or glass beads by means of thermal fusion. HERZOG machines are designed to achieve not only short preparation times and high sample throughput, but also maximum reproducibility and contamination-free results. This also applies to all other laboratory processes such as dosing and splitting samples.

Laboratory automation systems can be linear in design, with conveyor belts connecting the machines and analyzers. Alternatively, a multi-axis robot handles and transports sample cups to the automation components, which are arranged in a circle around the robot. PrepMaster Core, HERZOG's SCADA system, ensures optimized control of all components in the plant and laboratory.

PrepMaster Analytics is used to process analysis results and implement modern Industry 4.0 applications such as tool condition monitoring and predictive maintenance.

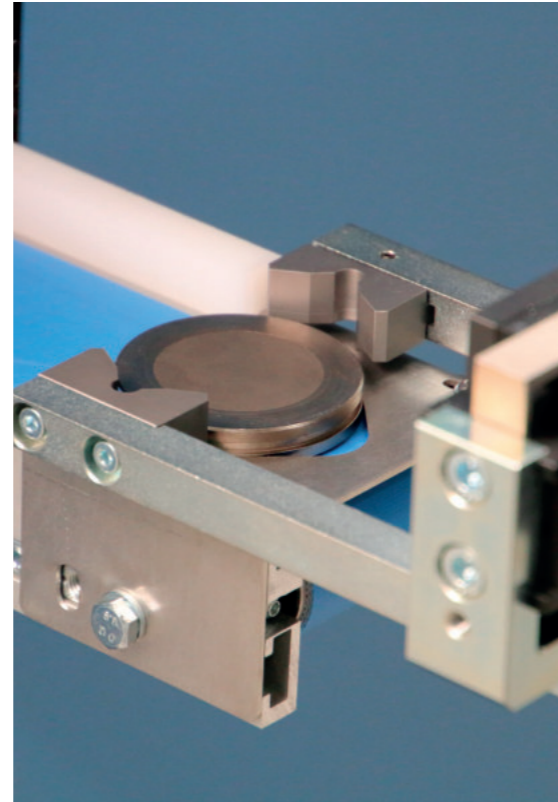
Combined mill and press HP-MP

The HP-MP is the state-of-the-art solution for grinding of granular material and preparation of pressed pellets. The compact dimensions, the wealth of functions and easy operation make the HP-MP the perfect choice for laboratory environments.

The HP-MP is extremely versatile and ready for different configurations: It can be used as a stand-alone machine with manual input and optional magazine function. The HP-MP can be integrated into a robot automation or linear automation using conveyor belts. Moreover, the HP-MP can be used for sample preparation within the plant as part of the AtLine Lab.

The HP-MP meets all requirements for efficient quality control of the production processes in the cement plant. Contamination is avoided by careful cleaning of all contact surfaces and optional use of a blind dosing system. The powerful hydraulic unit reaches pressures of up to 200 kN and is also suitable for demanding analytical tasks. Further functions of the HP-MP include the output of different subsamples for different analyses, exclusive grinding or pressing of samples, integrated ring cleaning, automatic dosing of different grinding aids, use of 40 or 51 mm rings, etc.

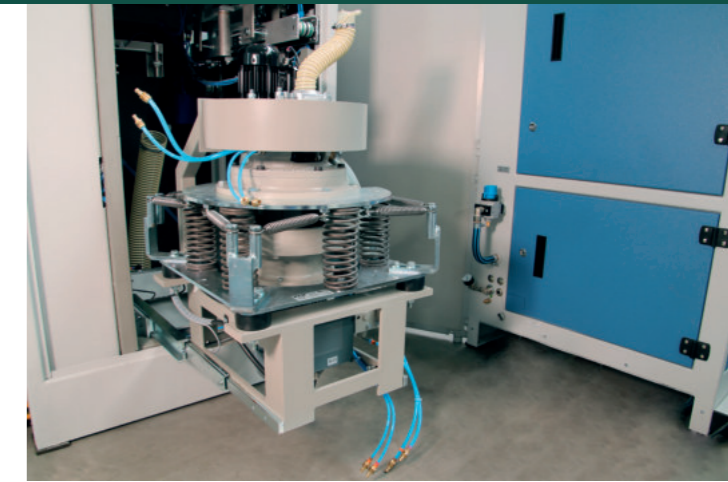
The HP-MP can be integrated into various Industry 4.0 applications with the help of PrepMaster Analytics software. The integrated sensor technology enables tool condition monitoring and predictive maintenance of the swing aggregate and the pneumatic cylinders, among other things.



Automatic mill HP-MA

The HP-MA is a fully automatic vibrating disk mill which can be operated either as a stand-alone machine, in a linear automation or in a robotic circuit. Optionally, the machine can be equipped with a 30- or 60-position input magazine, which allows the processing of larger sample batches.

Three cleaning modes are available, namely air, sand, granulate and wet cleaning. Depending on the sample properties, these cleaning options can completely prevent material carryover or reduce it to a low ppm range. In addition, it is possible to pre-contaminate the grinding vessel with a blank sample.



Automatic press HP-PA

The HP-PA produces pressed tablets of the highest quality with a smooth surface for optimal XRF analysis. With the help of the HP-PA, the necessary uniformity and density of the pressed tablets are achieved for the highest possible reproducibility of the analysis results.

All parameters of the HP-PA, such as pressing force, pressure rise and decay, as well as pressing force holding time, are adjustable. The relevant parameters are clearly displayed on the HMI panel and can be easily changed. Due to the program-controlled sequences, each sample is prepared identically. Errors due to incorrect sample handling are therefore excluded. In addition, the automatic sample preparation guarantees a high sample throughput. The HP-PA can be supplied with magazines for sample cups, steel rings and pressed tablets.



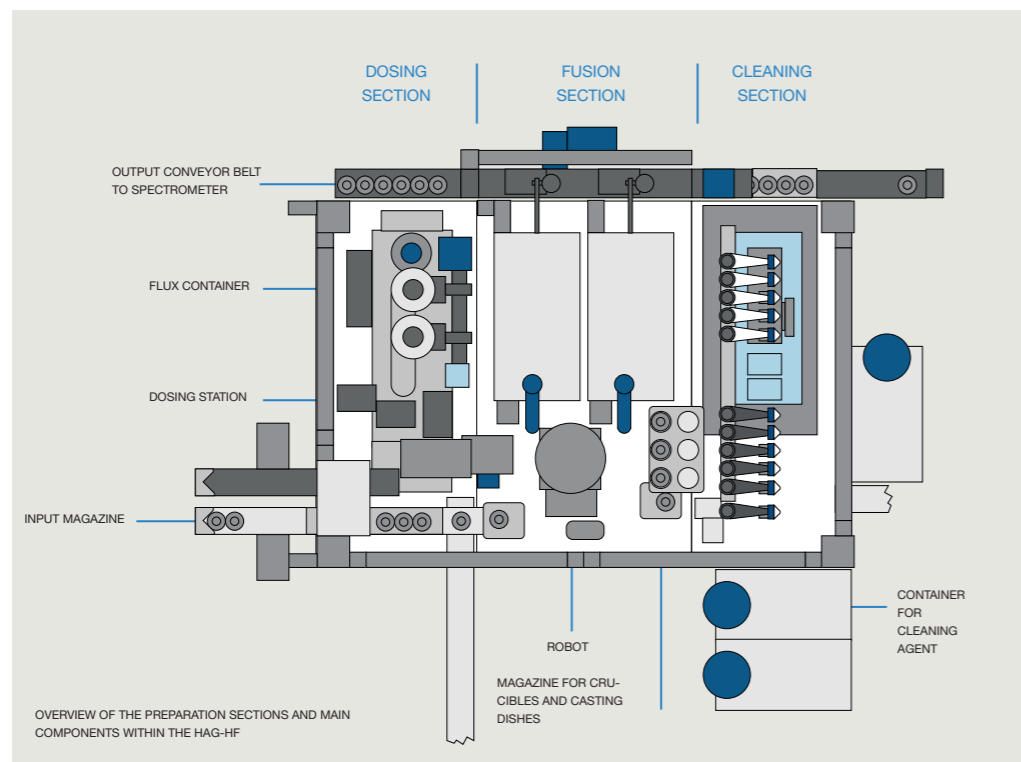


Automatic fusion system HAG-HF

Borate fusion is a standard method for sample preparation of samples from cement production and is used in many industrial and research laboratories. Sample preparation by fusion eliminates confounding factors such as particle size effects and matrix interference. In addition, glass beads produced by fusion are characterized by high homogeneity and structural consistency.

The HAG-HF prepares the samples fully automatically for X-ray fluorescence analysis and covers the following steps: Dosing of sample and fluxing agent, mixing of the sample, fusion and pouring into the casting dish as well as cleaning of the platinum dish. All units are housed within a compact machine stand and are operated by a multi-axis robot.

The HAG-HF can be used as a stand-alone machine or as part of a linear or robotic automation system. The HAG-HF has numerous flexible options for sample material input and transfer of the finished glass bead to the analyzer.



Automated laboratory systems

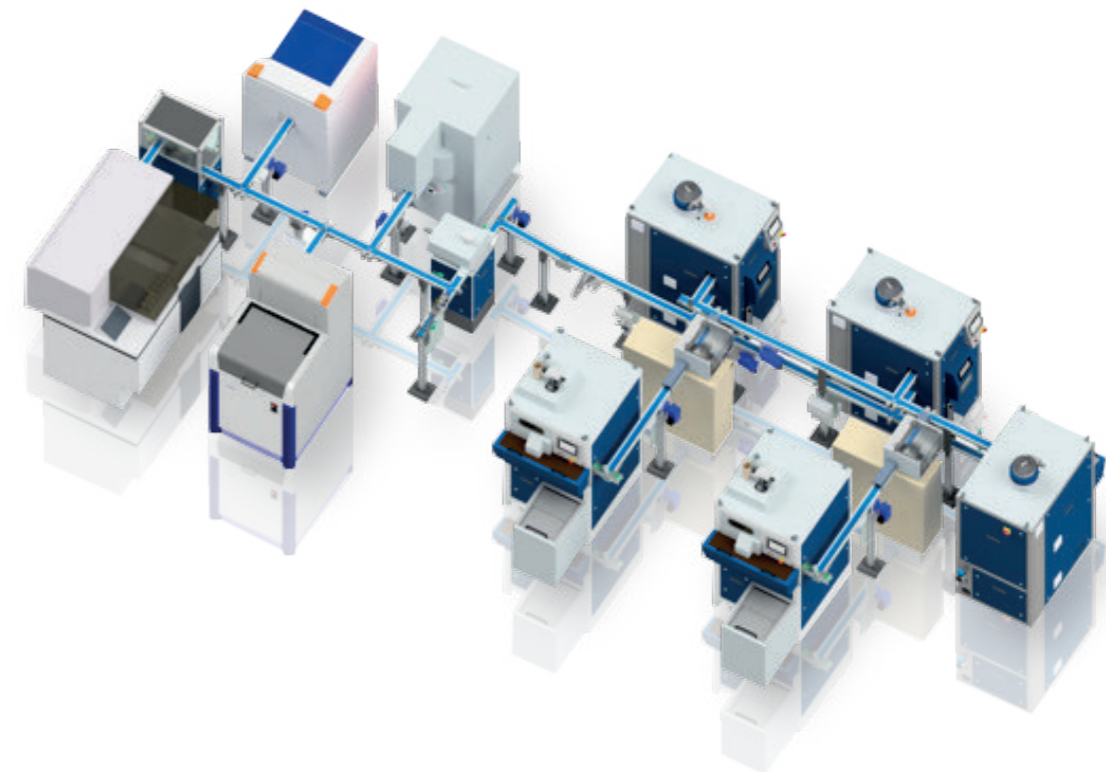
HERZOG has decades of experience in the field of automation technology. An interdisciplinary team of mechanical, electrical and application engineers as well as software programmers develop and configure automation solutions that are optimally tailored to the requirements of the cement industry.

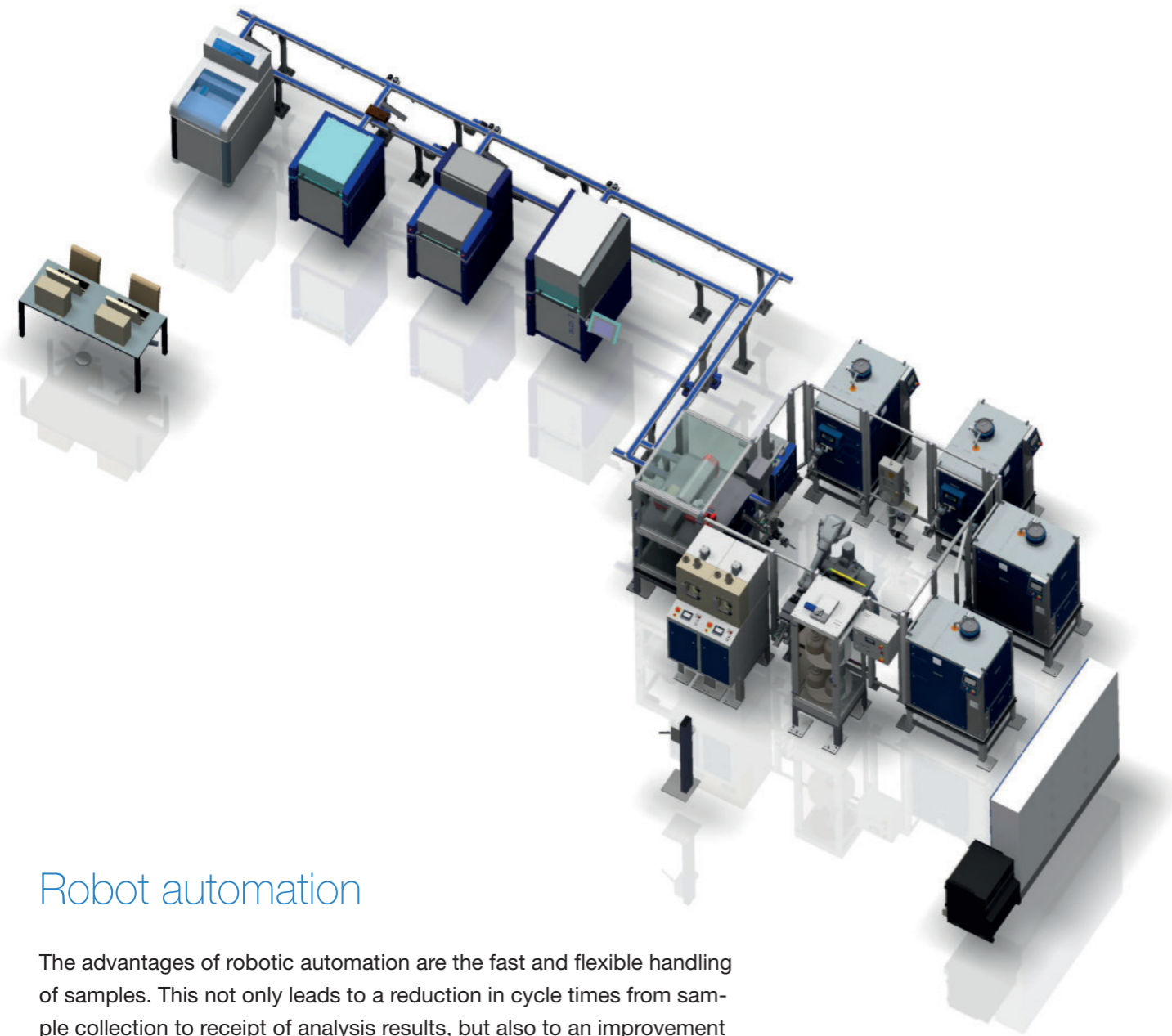
Linear automation

All components required for a fully operational cement automation are interconnected by means of belt conveyors. Automatic receipt of pneumatic carriers containing the sample material is carried out by means of one or more laboratory stations of the HR-LA or HR-LSP type.

After automatic emptying into a cup, the sample material is forwarded to one of the sample preparation machines like the combined mill/press HP-MP. Here, a pressed tablet is produced from the sample after grinding. However, sample preparation can also be carried out by a separate mill HP-MA and press HP-PA. In addition, a sample aliquot can be forwarded to the HAG-HF fusion system, where a glass bead is produced fully automatically.

All commercially available analytical devices for X-ray fluorescence analysis and X-ray diffraction can be integrated into a linear automation system. In addition, it is of course possible to integrate a wide range of other devices, e.g., for granulometry and colorimetry.





Robot automation

The advantages of robotic automation are the fast and flexible handling of samples. This not only leads to a reduction in cycle times from sample collection to receipt of analysis results, but also to an improvement in performance with a higher sample throughput. In addition, robotic automation also offers a great serviceability. Usually, all machines are freely accessible and can be serviced without shutting down the entire automation system.

Furthermore, robotic automation allows easy extension by adding further components. For example, an additional mill/press combination can be easily integrated as the number of samples to be analyzed increases. Also, an exchange of old components for newer machines is possible in most cases with little effort.

HERZOG robotic systems are equipped with modern safety components. For example, all automations are delivered with integrated safety functions in the robot controller to enable personnel-safe robot movements in any situation.



AtlineLab

The Atline-Lab is a compact laboratory that allows sampling, sample preparation and X-ray fluorescence analysis already in the cement plant. Raw meal and cement samples are collected via a sampler in a mixer, which enables the generation of a homogeneous and representative average sample.

The sample material is then volumetrically dosed into a cup and passed on to the combined mill/press HP-MP. There, sample preparation is performed by grinding and pelletizing into a ring. The pressed tablet is passed on to the analyzer via a belt connection.

Due to its proximity to the sampling point, the AtlineLab enables real-time analysis of critical products such as raw meal. The AtlineLab is thus a useful complement or substitute to a central laboratory in some cement plants. All components of the AtlineLab are contained in a robust and compact housing and protected from the dusty environment of the cement plant. At the same time, spacious access possibilities in the container ensure the full serviceability of the AtlineLab.

Manual sample preparation

HERZOG provides a comprehensive portfolio of manual and semi-automatic machines for the various sample preparation steps in the cement laboratory. The use of manual machines is suitable for smaller laboratories where automatic sample preparation is not necessary. In addition, manual machines also provide a backup solution when the laboratory automation is not available, for example, due to maintenance tasks.

Crushing HSC 550/ HSC 590

The HSC 550 and 590 are designed for pre-crushing and crushing of hard and brittle materials with a particle size of 50 and 90 mm. The machines are designed to meet the requirements of laboratory operation and allow easy and safe operation.



Grinding HSM

Due to its simple and ergonomic operability, low noise level and small footprint, the HSM is the optimal machine for laboratory operation. The HSM's programmable logic controller allows up to 30 different program sequences to be stored. The speed of the mill is continuously adjustable in a range between 750 and 1500 rpm. The automatic program sequence guarantees reproducible sample preparation and thus a high degree of accuracy and precision in material analysis.



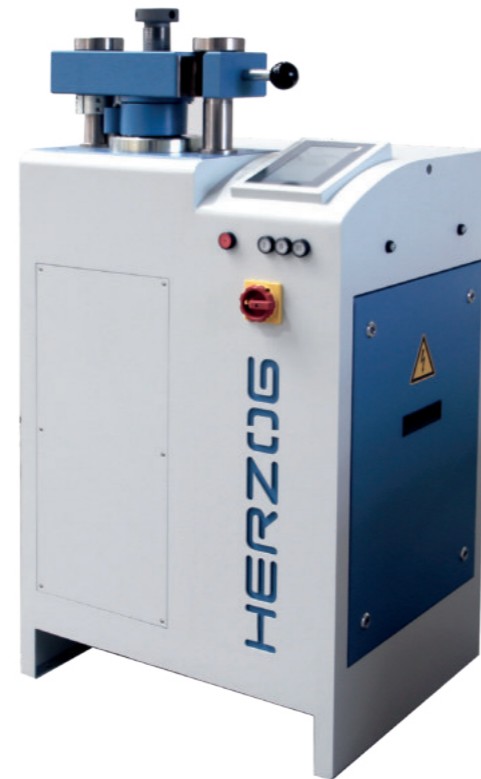
HP-M 100 P

The HP-M 100 P is a semi-automatic mill. After completion of the grinding process, the ground sample is discharged into a sample cup, which can be removed by the operator via a flap. At the same time, the grinding vessel is cleaned automatically. On the one hand, this reduces the workload of the laboratory personnel, and, on the other hand, it reduces the dust exposure within the laboratory.

Pressing

HTP

The press HTP offers all the advantages of program-controlled sample preparation for X-ray fluorescence analysis. All parameters for the pelletizing process such as pressing force, compression speed and pressure holding time can be set on the panel. This allows precise adaptation to the requirements of each material. At the same time, a high degree of reproducibility is ensured during sample preparation. In addition, the HTP allows the use of different pressing tools as well as free pressing.



TP 20E

The TP20E is a benchtop laboratory press that produces pressed tablets at the push of a button using the integrated hydraulic unit. This leads to a considerable reduction in physical strain and at the same time increases work efficiency. In addition to its small size, the TP20E is also characterized by particularly safe operation.



TP

The hand-operated hydraulic press can be used to perform all pelletizing operations required in the laboratory. The hydraulic pump is operated with a hand lever. Depending on the type, the TP can achieve a maximum pressure of between 200 and 600 kN.

Fusion



Bead One HF

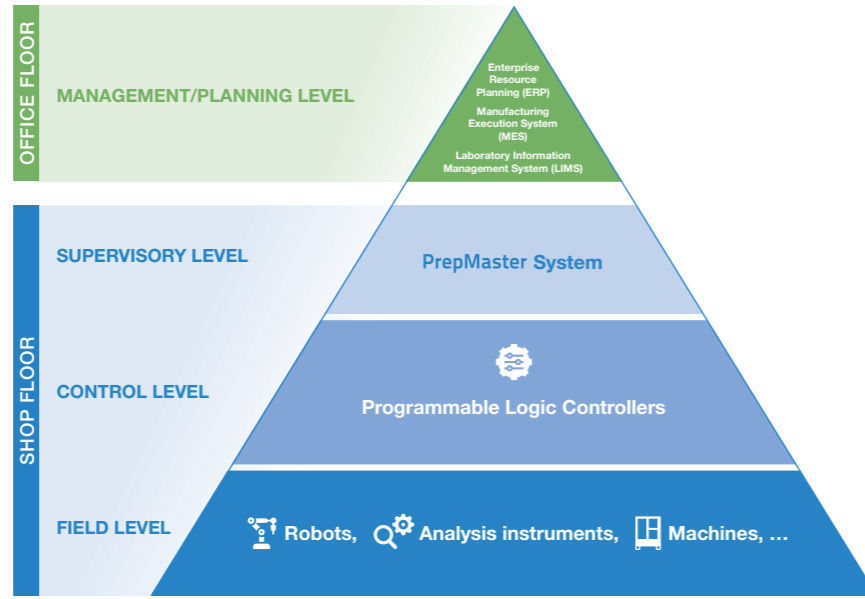
The Bead One HF is a benchtop fusion machine using high-frequency induction technology. The Bead One HF enables the fast and process safe production of high-quality glass beads. Due to the induction technology, target temperatures can be reached within a very short time, resulting in an increased sample throughput. The cold-to-cold operation of the Bead One HF ensures safe operation without getting in contact with hot vessels or material.



Bead One R

The Bead One R is a benchtop fusion unit using resistance furnace heating. The fusion process can be precisely controlled by the parameters of temperature, fusion duration, heating speed and rocking speed. After fusion, the material can either be emptied into a casting dish or left in the crucible to solidify. Alternatively, the melt can be poured into a container of acid positioned on a magnetic stirrer. With the help of the optional magazine, pre-dosed sample batches can be processed fully automatically.

PREPMASTER STRUCTURE



Herzog's software solutions ensure optimal integration of all levels of the Shop Floor and build flexible and robust connections to the customer's Office Floor applications.

PrepMaster Suite

The PrepMaster Suite is a fully integrated SCADA system used for the automation, control, monitoring and evaluation of all processes in the laboratory and plant. The PrepMaster Suite is fully scalable, modular and readily expandable. The software enables the integration of a wide range of application-specific machines and instruments from various original equipment manufacturers. The PrepMaster Suite can be easily integrated into the customer's IT infrastructure and offers powerful interfaces for inter-process communication. Accordingly, PrepMaster can simply connect to other instances in the Shop and Office Floor, such as manufacturing execution systems (MES), ERP systems or LIMS applications.

PrepMaster Core and PrepMaster Analytics are autonomous modules that can be used independently of each other. However, the full PrepMaster functionality is only available when both modules are installed and can communicate with each other. PrepMaster Remote is a supplement to PrepMaster Core, which allows PrepMaster to be extended to a multi-user system.

OVERVIEW – FUNCTIONS OF PrepMaster modules

PrepMaster Core	PrepMaster Entry	PrepMaster Remote	PrepMaster IDE	PrepMaster Analytics
Automation monitoring and control (SCADA System)	Automation monitoring and control (SCADA System)	Web-based operator terminal for multi-user capability of PrepMaster Core/Entry	Integrated developer environment for configuration and programming of PrepMaster Core/Entry	Recording, documentation and monitoring of all relevant data of the laboratory
Applicable for any automation	For automations with up to two analyzers and one functional sample preparation unit	Applicable for any automation	Applicable for any automation	Applicable for any automation with PrepMaster Core/Entry
<ul style="list-style-type: none"> ▶ Sample registration ▶ Sample routing ▶ Management of worksheets ▶ Overview of sample status ▶ Overview of the functional status of the system ▶ Establishment of interfaces to all system components and office floor systems ▶ Management of reference samples 	<ul style="list-style-type: none"> ▶ Sample registration ▶ Sample routing ▶ Management of worksheets ▶ Overview of sample status ▶ Overview of the functional status of the system ▶ Establishment of interfaces to all system components and office floor systems ▶ Management of reference samples 	<ul style="list-style-type: none"> ▶ Overview of the functional status of the system ▶ Sample registration ▶ Control of the unit status ▶ Change of the sample status 	<ul style="list-style-type: none"> ▶ Configuration of projects ▶ Configuration of individual units, programs and parameters ▶ Programming of sample routing ▶ Configuration of handling systems ▶ Automatic error detection 	<ul style="list-style-type: none"> ▶ Processing of analysis data ▶ Monitoring of calibration status ▶ Validation of analysis data ▶ Determination of measurement uncertainty ▶ Monitoring of system performance ▶ Summary of all sample data (Sample Vita) ▶ Planning of service activities ▶ Tool Condition Monitoring ▶ Predictive maintenance ▶ Rawmix and blending module for cement production

PrepMaster Core

PrepMaster Core – the key application of the PrepMaster Suite – is used to monitor and control HERZOG automatic systems. The entire software architecture is based on a machine-oriented code and geared towards high reliability to guarantee 100% automation availability. In addition, great importance was given to the usability of the software, which allows the user to operate the system as simply and effectively as possible.

The main functions of PrepMaster Core:

- **Easy monitoring and control of the system:** PrepMaster Core offers a user-friendly GUI. All relevant information on the status of the system, components and samples is clearly displayed. Sample worksheets can be easily configured and modified. The PrepMaster Remote module provides web-based access to all important operating and monitoring functions for additional operators without additional client-side installations.
- **Adaptive and priority-controlled sample management:** The PrepMaster Core routing module enables the fast and efficient preparation of samples in the steel laboratory. The intelligent sample administration easily manages even high sample volumes and peak workloads. Priority samples are routed before other samples to make critical analysis results available as quickly as possible.
- **Optimum serviceability:** Several integrated service tools enable the fast diagnosis of the system's functional status, facilitate the analysis of errors that have occurred, and help to optimise the system. The corresponding diagnostic information can be evaluated by the user or sent as diagnostic files to the HERZOG specialists. HERZOG employees can access the system via secure remote access.

PrepMaster Analytics

PrepMaster Analytics is a modern Industry 4.0 application for recording, logging and monitoring all relevant data and processes of an automated system. PrepMaster Analytics provides a holistic overview of all important key performance indicators and significantly improves the process efficiency and reproducibility of sample preparation and analysis.

PrepMaster Analytics features include:

- **Acquisition, presentation and processing of analytical results:** For data acquisition, PrepMaster Analytics includes preconfigured interfaces for a wide range of analysis instruments. Data can be displayed in a variety of ways in tabular and graphical form on various dashboards. Data can also be edited manually or automatically, with all changes logged automatically. Users can track and monitor data in a number of ways. The application also accounts for measurement uncertainty while monitoring the analytical results.
- **Monitoring the calibration status of analysis instruments and validation of analytical results:** PrepMaster Analytics allows the automatic display and continuous monitoring of reference analyses using statistical process control (SPC) tools. It links the relevant analyses of a production sample with the relevant reference analyses. This ensures that each analysis in the laboratory is performed under referenced conditions and is validated. These procedures are logged automatically and are available in the event of an audit, e.g. in the context of ISO 17025.
- **Monitoring of automation performance:** PrepMaster Analytics provides all the necessary tools for visualising and monitoring the performance of the automatic system. Important key performance indicators can be tracked and evaluated in real time. Typical KPIs relevant for evaluating the performance include sample throughput, cycle time, and processing times. Simultaneously, the data provides information about further optimisation options within the system.



Screenshots of PrepMaster Analytics

- Overview and summary of all important sample data:** The Sample Vita module of PrepMaster Analytics combines all relevant data on the preparation and analysis of a specific sample in a central data dashboard. It clearly presents all the relevant routing data, machines and instruments used, sample preparation times and steps, as well as analysis results for a sample. This means that all data is available at any time for the complete documentation of sample preparation and analysis, e.g. as part of an ISO 17025 audit.
- Documentation, planning and monitoring of service and maintenance activities:** PrepMaster Analytics contains various tools that make maintenance, service and issue resolution much easier. The maintenance module enables the simple setup and definition of automation components and related maintenance tasks. Furthermore, maintenance progress and efficiency can be evaluated statistically. The systematic recording of availability as well as warning and error messages not only facilitates fault analysis, but also provides laboratory management with a quick overview of the system's performance.
- Condition monitoring and predictive maintenance tool:** PrepMaster Analytics offers optional modules for monitoring different machine tools using sensor data. This enables the monitoring of appropriate sample preparation, the control of the tool condition (TCM), and the performance of predictive maintenance.

RAWMIX AND BLENDING MODULE FOR CEMENT PRODUCTION

The Rawmix and Blending module of **PrepMaster Analytics** is based on advanced optimisation algorithms and model predictive control mechanisms. As a result, optimal raw material flows are calculated even for complex initial situations and boundary conditions. The sophisticated software control makes it possible to reach defined setpoints quickly and accurately and to stay within them.



Simple configuration

- Quick access to all configuration menus
- Clear and sortable display of all data
- Easy change of parameters, e. g. of belt feeders, raw materials etc.



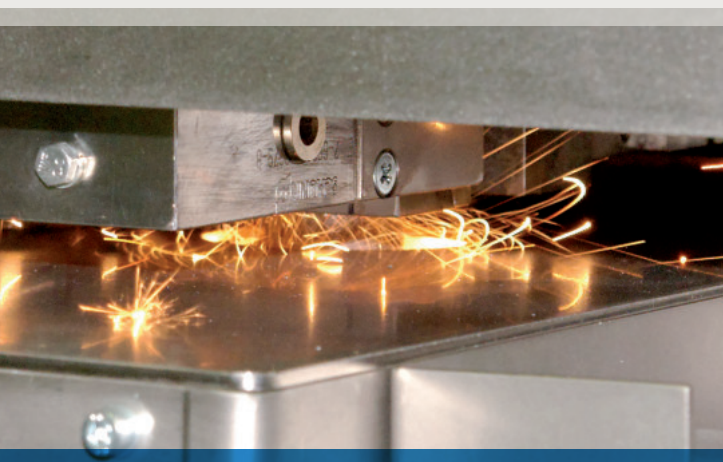
Clear dashboards

- Presentation of all relevant parameters for cement production
- Overview of all relevant modules and feeder settings
- State evaluation of the system, including goals achieved and fulfilled degrees of freedom



Automatic acquisition and calculation

- Automatic acquisition of analysis values
- Calculation of target values by means of the model predictive control algorithm
- Optimised target value achievement under the selected constraint conditions



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