Raw material preparation.

From the quarry to raw meal feeding into the preheater.

A company of ThyssenKrupp Technologies

Polysius

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Future-oriented raw material preparation solutions made by Polysius:
Innovative – Individual – Ideal.

The manufacturing of cement begins with the extraction and preparation of raw material – a process covering the stages from raw material quarrying to feeding the raw meal into the preheater.

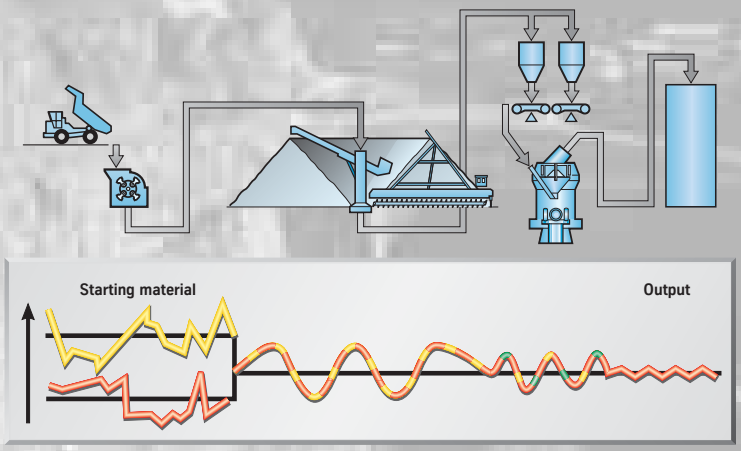
The purpose of optimum raw material preparation for the cement manufacturing process is to supply the downstream burning process with a raw meal whose quality and homogeneity assures the economical production of high-quality cements. This can only be achieved if the plant designers have precise knowledge of the materials that will be used (raw materials and fuels). This is the basis for purposive selection of the production process, including the blending, storage, homogenisation, grinding and analysis systems.

As the first step, experienced geologists determine the available raw material deposits. Next, the chemical, mineralogical and physical laboratories of the Polysius Research Centre analyse, evaluate and test the raw material samples. Thanks to the very extensive Polysius database, the materials are reliably classified even if a relatively small amount of data is available.

Taking into account the determined material properties and the customer-specific boundary conditions, the required machines and analysis equipment is then selected, dimensioned and arranged. To obtain sufficient latitude for the creation of alternative design solutions, Polysius uses ISAR. This database-linked software program allows the very fast simulation of different plant and process configurations on a PC, including the resulting development of raw material homogeneity. This ensures that the optimum process-technological and economic solution is found for every individual project.

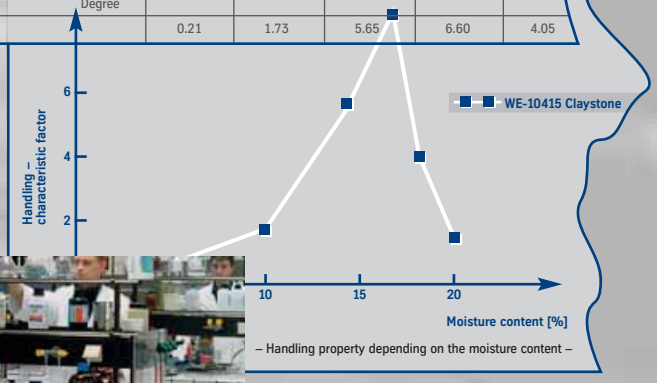
Whether a given deposit is a suitable supplier of raw materials for the cement production process is decided on the basis of precise examination and analysis data. As a first step, geologists prospect the deposit.

From the PC to reality: because of the diversity of raw material deposits, simply stringing standard individual processes or even just machines one after the other is not enough. The desired success can only be achieved if a comprehensive view is taken, including the obtained raw material data and the necessary investment and operating costs. ISAR – a totally unique software program – allows quick creation and simulation of an optimum raw material preparation concept.



Shear Test evaluation for moist materials – Polysius AG/Research and Development –

		1	2	3	4	5
Client		Singfa	Singfa	Singfa	Singfa	Singfa
Material		Claystone	Claystone	Claystone	Claystone	Claystone
WE-No.		10415	10415	10415	10415	10415
Test-No.		0415C05	0415C10	0415C15	0415C16	0415C175
Moisture content		5.0	10.0	15.0	16.0	17.5
Normal stress	g/cm²	200	200	200	200	200
Greatest consolidation stress	g/cm²	502	508	489	482	455
Bulk material strength	g/cm²	92	184	262	271	227
Effective angle of friction	Degree	39	42	45	46	43
Bulk material cohesion	g/cm²	24.5	52.1	80.8	86.3	71.7
Flow function	ffc					
ffc < 1	Hardened					
ffc < 2	Very cohesive Non-flowing			1.9	1.8	
2 < ffc < 4	Cohesive		2.8			2.0
4 < ffc < 10	Easy flowing	5.5				
10 < ffc	Free flowing					
Angle of wall friction	St-37 Degree			27.0	24.5	
Angle of wall friction	PVC Degree			23.9	19.8	
Angle of wall friction	Degree					
Handling behaviour		0.21	1.73	5.65	6.60	4.05



– Handling property depending on the moisture content –

The determined material properties are the basis for the plant configuration.

After the material-specific preparation of the representative material samples supplied by the geologists, laboratory tests determine the chemical and physical properties which form the basis for evaluation and classification of the raw materials.

The process chain at a glance.

● **Crushing:** crushers break up the raw material delivered from the quarry and provide the raw mill with the feed size range it requires.

Crushers

● **Raw material analysis:** the POLAB® CNA online analyser provides the first data regarding the chemical contents and/or homogeneity of the raw material.

POLAB® CNA

● **Bulk material storage / blending / metered feeding:** the raw materials are buffer stored in stockpiles or homogenised in blending beds and then supplied to the grinding process in the required flow rate and composition either directly or via feed bins.

Longitudinal stockpile/longitudinal blending bed
Circular stockpile/circular blending bed
Flow regulation bin

● **Grinding/drying:** the raw material is ground in the raw mill to the fineness required by the downstream clinker burning process and dried.

QUADROPOL® roller mill
DOROL® roller mill
Air-swept tube mill
POLYCOM® high-pressure grinding roll

● **Raw meal analysis:** the raw meal samples are analysed at short intervals and the analysis data are used as the basis for controlling the raw material composition and mill feeding.

POLAB® AOT
POLAB® AMT

● **Final raw meal homogenisation/storage:** the raw meal is homogenised and stored in silos and then supplied at a regulated flow rate to the preheater.

Multi-cell silo
Tangential blending silo
Filter dust handling
Dosing and conveying systems

Everything starts with the **raw material quarrying.**

Depending on its characteristics, the raw material needed for the cement production process is quarried by blasting, hydraulic excavators or ripping. A wide range of crushing plants – depending on the material's properties and type of extraction – can be used for breaking the extracted raw material to the size required by the raw mill. Polysius always installs crushers from renowned manufacturers.

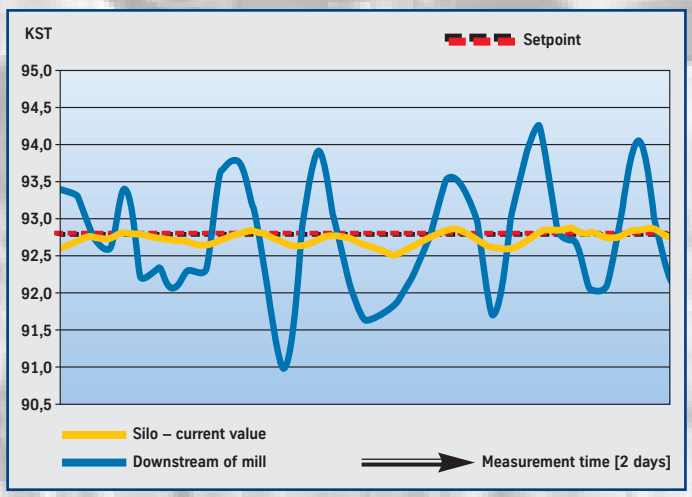
High-performance analyser trio assures quality
the vital factor.

While the raw materials and fuel grades are becoming more and more complicated (primarily due to the increasingly problematic raw material deposits and the use of secondary materials), the demands on clinker quality are increasing. This makes quality assurance with highly effective analysis systems an absolutely indispensable component of the raw material preparation process.

No generally valid concept can be applied, but it is clear that the more complex the raw materials and fuels the more difficult it is to determine the right quality assurance concept for the particular application involved.

With the POLAB® CNA for online analysis of the raw material upstream of the blending bed, POLAB® AOT for online analysis of the raw meal downstream of the raw material grinding system and POLAB® AMT, the sample preparation and analysis system in the central laboratory, Polysius offers high-performance systems that provide information about the chemical composition and homogeneity of the materials at quality-relevant points of the process and initiate appropriate control interventions. The systems are equipped with an adaptive mixture control which calculates the raw meal mixture in advance and thus reliably maintains the setpoint value.

The POLAB® AOT raw meal analyser, whose footprint of only 2.2 m (!) means that it can also be retrofitted without any problem, performs one control cycle every 10 minutes; i.e. every 10 minutes a raw meal analysis is performed and the weighbelt setting of the raw mill feed system is corrected by the adaptive mixture control.



Installed directly downstream of the raw mill, the POLAB® AOT takes raw meal samples at short intervals, fine-grinds them, analyses them with its energy dispersive X-ray fluorescence analyser and controls the raw material composition and mill feeding.

Use of the POLAB® CNA analysis system upstream of the blending bed ensures the earliest possible knowledge of the chemical content and homogeneity of the raw materials. The entire flow of gravel-sized raw material coming from the crusher passes through the online analyser.

POLAB® AMT, the sample preparation and analysis system installed in the central laboratory, performs all quality assurance functions for a complete cement production line.

The POLAB® CNA determines the process-relevant oxide concentrations of the entire stream of material (no matter whether it is an individual component like limestone, marl or clay, or mixtures of these) without requiring any pre-treatment. On the basis of the analysis results, the quality of the starting materials can be controlled at an early stage, thus enabling optimum blending bed stacking. Thanks to the modular design of the POLAB® CNA it can be installed very quickly, even into an existing conveying system.

The right mixture is crucial.
Requirement-oriented blending and storage configurations.

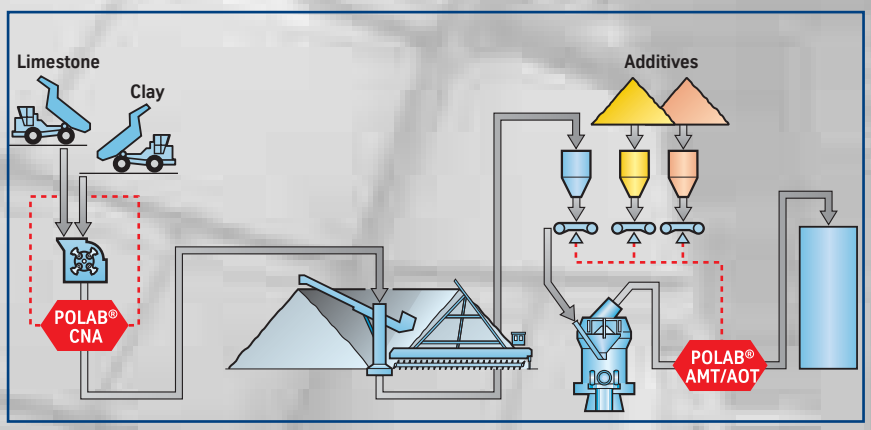
Raw material preparation with integrated blending bed

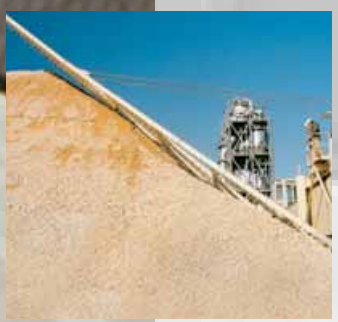
The raw material preparation concept with an integrated blending bed has established itself as the ideal solution for material components with »normal« and acceptable handling properties.

The composition of the blending bed is controlled by the online analyser POLAB® CNA, which regulates the supply of different components to the crusher or before the blending bed and thereby keeps the chemical values close to the setpoints. Upstream of the mill a precision adjustment then takes place on the basis of the raw meal analysis and the addition of corrective components by the adaptive mixture control.

The final homogenisation usually takes place in a tangential blending silo.

Raw material preparation concept with integrated blending bed – the ideal solution for material components with normal and acceptable handling properties.





For efficient storage and homogenisation of the raw materials, Polysius offers a broad range of blending bed and storage technology for circular and longitudinal installations with harmonised stacking and reclaiming methods.

Raw material preparation for materials with extreme handling properties

More and more often, the materials used have extreme handling properties (e.g. are very sticky or extremely moist), tend to segregate or are simply not simultaneously available.

In these cases the individual components have to be specially stored and prehomogenised to suit their handling and homogeneity properties. These components remain separate until just before they are fed into the grinding plant. Particularly in the case of materials that are difficult to handle, the best solution is direct feeding from the storage facility into the mill.

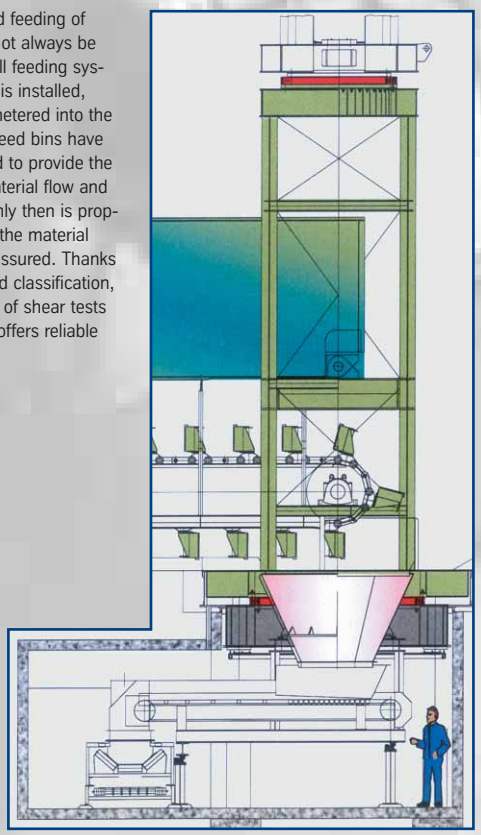
In the case of longitudinal stockpiles that are stacked discontinuously, the direct feeding system can consist of a combination of several reclaimers. For circular blending beds, specially designed discharge systems are generally used. With a direct mill feeding system there is no need to convey the critical material into an additional feed bin, which eliminates the otherwise necessary investment cost for the feed bin and associated discharge regulation system. A POLAB® AOT online raw meal analyser performs the mixture controlling.

An important precondition for direct mill feeding from the blending bed is the assurance of a uniform flow of material. For this reason, the central chute of the circular blending bed's bridge scraper is used as a small buffer bin, which particularly compensates short-wave discharge fluctuations. The compact Polysius blending bed design, in which the chain of the bridge scraper passes through the central column, ensures that the material falls into the centre of the chute and does not adhere to its walls.

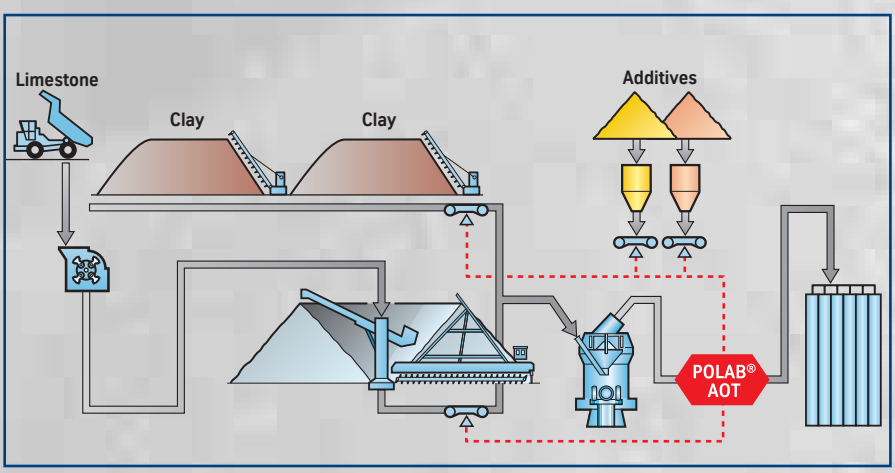
The filling level of the central chute is captured with a filling level measuring device. If the filling level falls, the travel speed of the bridge scraper is automatically increased, which raises the reclaiming capacity.

The direct mill feeding system can also be used if the circular blending bed is located at a great distance from the mill.

Feed bins for flow-regulated feeding of the raw grinding plant cannot always be avoided. Even if a direct mill feeding system from the blending bed is installed, additives may have to be metered into the stream of material. These feed bins have to be correctly dimensioned to provide the required buffer size and material flow and handling characteristics. Only then is proper outflow and metering of the material components permanently assured. Thanks to material investigation and classification, as well as the performance of shear tests if necessary, Polysius also offers reliable feed bin solutions.



Principle of a direct mill feeding system.



Raw material preparation for materials that are extremely difficult to handle.

Raw material grinding plants.
The requirements determine the mill type.

Polysius offers a comprehensive range of grinding processes. However, the right choice of grinding plant for the respective application is governed by numerous criteria.

Apart from the raw material properties and the required throughput capacity, the capital investment, operating costs and availability are particularly important factors.

The tube mill is a proven, simple and easy to maintain machine, which also involves the lowest capital cost.

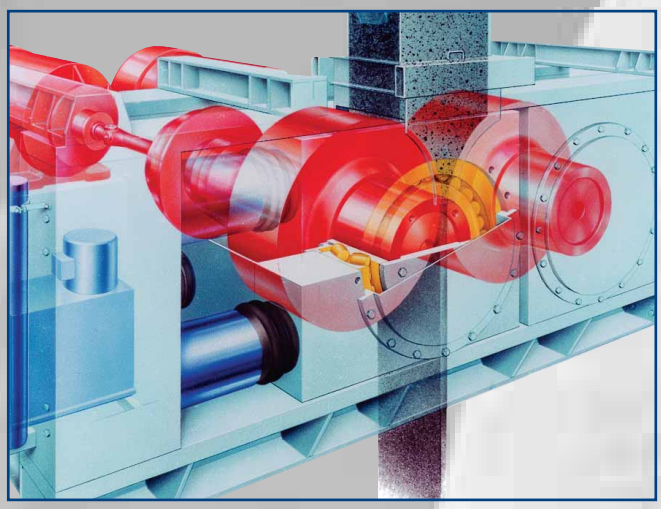
Its main disadvantages are significantly higher energy consumption compared to other grinding processes and low material drying capability.

The POLYCOM® high-pressure grinding roll has the lowest energy requirement and can be readily combined with other grinding processes, to achieve great increases in output. However, the POLYCOM® also has a limited material drying capability.

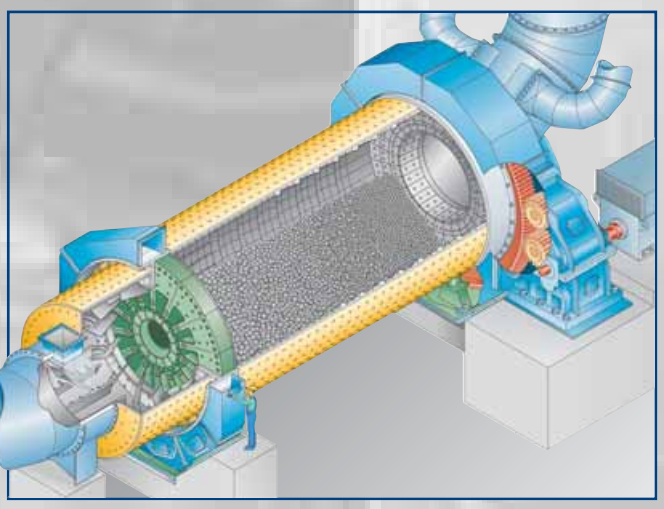
In about 85 percent of all raw material grinding applications the roller mill is nowadays used. It offers the advantage of combining three work operations – grinding, drying and separating – in one compact unit. The design of the DOROL® double-roller mill, well-known from over 250 installations all around the world, has been advanced. The result is the QUADROPOL®, which offers high throughput rates, low construction size and high availability. The QUADROPOL® has four grinding rollers, whose bearings are located outside the mill and are thus protected against dust and high temperature. The mill can be automatically switched over from 4 to 2 roller operation, which provides great flexibility and the ability to adapt to changes in raw meal requirement. For maintenance purposes, each pair of opposite grinding rollers can be pivoted out of the mill housing. The two roller units remaining in the mill then take over the comminution process, which is a precondition for online operation with an uninterrupted flow of material from the mill into the kiln.

Good accessibility, easy maintenance and the possibility to change over to partial-load operation with 2 roller units without interrupting operation complete the convincing QUADROPOL® concept.

The POLYCOM® can be used as a primary mill, or in combination with, for instance, tube mills or as an autonomous finishing mill. The more grinding work is shifted to the high-pressure grinding roll, the higher is the energy saving compared to other systems.



The DOROL® double-roller mill is the standard roller mill for grinding a very broad range of materials including coal, blast furnace slag and clinker. This mill type has been constantly refined and optimised over the years, and has thus achieved an excellent level of efficiency and reliability.



Simple plant concept and low capital costs are characteristic for the air-swept tube mill.

Silo systems from Polysius
for an uncompromising final homogenisation.

In the case of raw meal silos, the trend towards more complex raw materials demanded an increase in their homogenisation capabilities and range of functions. Investment constraints also affected the requirement profile by forcing a reduction in silo size.

The raw meal silo performs two functions: on the one hand it acts as a raw meal store, ensuring that the kiln is supplied with raw meal even during raw mill stoppages. On the other hand, it has the task of homogenising the raw meal produced by the raw mill to an extent which ensures that the kiln can produce a consistently high clinker quality. The silo has to maintain the degree of homogeneity achieved in the preceding process sections or to raise it to the target homogeneity, if this has not yet been reached. the principle of homogenisation is the storage of horizontal layers which each have different quality characteristics, followed by the vertical blending of these layers when discharging the silo.

Having thoroughly reengineered the standard blending silo, Polysius offers the tangential blending silo and the multi-cell silo as solutions for the new requirements.

Tangential blending silo

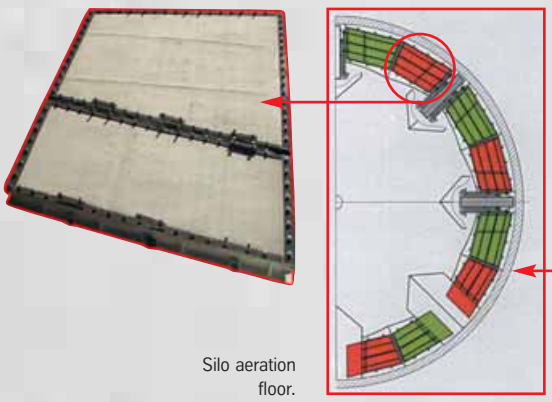
The tangential blending silo consists of the silo shell, the distributing system, the inner cone, the aeration surface with the discharge systems, the central mixing chamber, the aeration system and the dust collection filter.

The raw meal is fed into the silo through the distributing system. Compared to the conventional blending silo, the number of feeding arms has been increased and a central infeeding point has been installed. As the feeding arms are alternately activated by a control system, it is not possible for the coarser grain size fraction of the raw meal to permanently fall straight down onto the same point and form a pile of large-sized material. The special silo filling process thus already counteracts segregation of the raw meal.

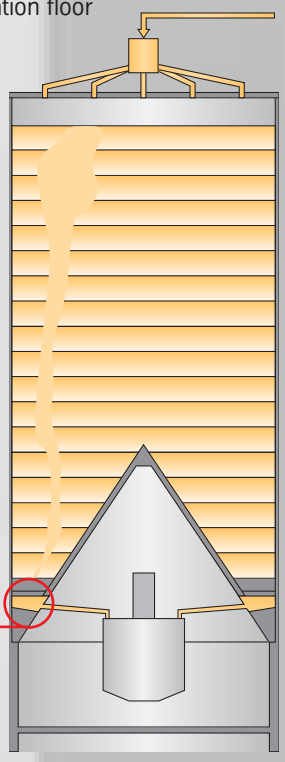
The new tangential blending silo has a unique aeration floor which covers almost the entire ring area at the bottom of the silo and thus ensures optimum aeration of the raw meal. The material can be fluidised and extracted at all points of the silo floor. The aeration floor is of modular and compact design and can therefore be simply, efficiently and thus cost-effectively installed.

The main process technological advantage of this type of silo is derived from the new mode of operation of the central mixing chamber with constant filling level. Due to the silo floor being completely covered with aeration panels with a large number of outlets, it is possible to generate discharge funnels that go through the entire charge of raw meal, even if it is non-freely flowing or otherwise problematic. The discharge and filling times for the material in the mixing chamber that is withdrawn from one segment of the silo can be individually adapted to the size of the silo and mixing chamber, as well as the properties of the material. The constant filling level in the mixing chamber also results in a constant discharge behaviour, which ensures that the downstream flow regulating units receive an optimum feed flow of material.

The combination of the new systems, POLAB® AOT analyser and tangential blending silo, is one of the most innovative raw meal homogenisation and storage configurations on the market.



Silo aeration floor.



Blending and discharge behaviour in the tangential blending silo.

Multi-cell silo

The multi-cell silo, which is a combination of small silos, is particularly used in cases where the raw meal has a strong tendency to segregate (in response to the trend towards complex raw materials) and/or in processes demanding the homogenisation of small storage volumes (in response to the requirement for smaller raw meal silo capacities).

The small individual member silos of the multi-cell silo are filled one after the other but discharged simultaneously. The product is then fed directly to the preheater. In this way, a reliable blending effect is achieved. The silos are so designed that mass flow is ensured and no segregation can occur.

An important difference to the already known multi-compartment silo systems is that the simultaneously discharged material is directly fed to the pre-heater and not first kept in storage silos (where experience shows that segregation can again take place).

Cone and outlet of the multi-cell silo.

The advantages of the multi-cell silo at a glance:

- A defined minimum blending effect is ensured, even in the case of very complex raw materials.
- The size of the individual silos ensures a constant mass flow.
- For maintenance purposes one silo can be taken out of the combination and inspected without affecting or even stopping the system operation.
- Any raw meal tonnages that differ greatly in quality (first cut of a blending bed, filter dust in mill bypass operation) can be filled into one silo and subsequently slowly proportioned into the main flow.
- If the capacity of the complete plant is increased, the raw meal capacity can be easily and cost-effectively raised by adding on further small silos.

The individual cells of the multi-cell silo are filled one after the other but emptied simultaneously.