

Combined Grinding and Drying Plant with NEA Pendulum Mill for a Red Sandstone/Clay Mix

This report describes a combined grinding and drying plant for a red sandstone/clay mix used for making high-quality clay roofing tiles with superior surface finish realized for ERLUS AG based in Teistungen, Germany. The plant was supplied by NEUMAN & ESSER GmbH Mahl- und Sichtsysteme/DE.

Introduction

In Teistungen, Thuringia, ERLUS AG /DE owns a relatively large deposit of red sandstone, which is suitable for the manufacture of high-quality roofing tiles and are sufficient for the company to assure the supply of its roofing tile production at the site with its own raw materials for the next decades. At the end of 2007, ERLUS decided to invest in a dry preparation line and began searching for a suitable grinding system. In July 2008, following successful grinding and drying tests, NEUMAN & ESSER GmbH/DE was awarded the contract to supply a combined grinding and drying plant incorporating a PM16U3 pendulum mill. In autumn 2009, the new roofing tile production was commissioned.

Material flow

The red sandstone at the surface of the slope is removed layer by layer with a scrapedozer and transferred on a wheel loader to the nearby crushing plant (Fig. 1–2). From there, the pre-crushed red sandstone is picked up by a wheel loader and filled into a box feeder. Variegated sandstone and the clay gravimetrically added from two other box feeders are brought together on a belt conveyor and then comminuted in the roller crusher to a particle size up to 40 mm. The mixed material with a moisture content of 10–14 % H₂O is transferred to a box feeder, which is both pre-hopper and material feeder for the pendulum mill grinding plant. On the speed-controlled apron conveyor of the box feeder the material to be ground is fed to the pendulum mill, and in the mill it is dried and ground at the same time. After separation in a bag filter, the ground product is stored intermediately in two 60-m³ product silos. The dried



Fig. 1 (l.)
Red sandstone reserves for the next decades, right next to the roofing tile production facilities

Fig. 2 (r.)
Pre-crushing plant for red sandstone

red sandstone/clay powder is mixed with additives and water in intensive batch mixers. This finished blend with a moisture content of around 14 % H₂O is then sent to the souring house for storage and moisture balancing. After being pressed, dried and fired in a 120-m-long tunnel kiln, the finished clay roofing tiles are sent to final sorting, packaging, storage and dispatch.

Dry preparation

Pendulum mills have proven effective in combined grinding and drying for the dry preparation of clays and clay-like raw materials for the production of roofing tiles and ceramic tiles, and have been successfully used for decades now. High-quality clays may also contain impurities like pyrite, basalt and other minerals, which at particle sizes of around 200 µm can lead to unwanted reactions and melting defects on the surface of the ceramic. To avoid the above-mentioned surface defects, the material mix must be ground to an acceptable fineness and the upper particle size must be strictly limited.

Grinding plant with filter connection

The feed material is fed steadily by the box feeder with the speed-controlled apron conveyor into the pendulum mill and falls into the grinding zone. In the material bed,

between the grinding ring and the grinding rolls rolling on it, the clay is comminuted with compression and shear forces. The stream of hot air entering the grinding zone moves the mill feed from the grinding chamber into the dynamic air classifier integrated in the mill. The speed of the classifier wheel can be infinitely adjusted over a wide fineness range. This means changes to the product fineness can be made quickly and easily. Clay powder with a fineness of 7 % >100 µm (99,9 % <200 µm) and a residual moisture of around 2 % H₂O is separated in the bag filter downstream of the mill and discharged in a mass flow of 25–30 t/h (Fig. 3–4).

Why combined grinding and drying?

The pendulum mill is suitable for the comminution of brittle, dry and free-flowing materials. In cold grinding, wet and sticky feed materials with a high water content and highly plastic shaping behaviour cause product caking and sticking between the grinding ring and rolls, so that continuous comminution would not be

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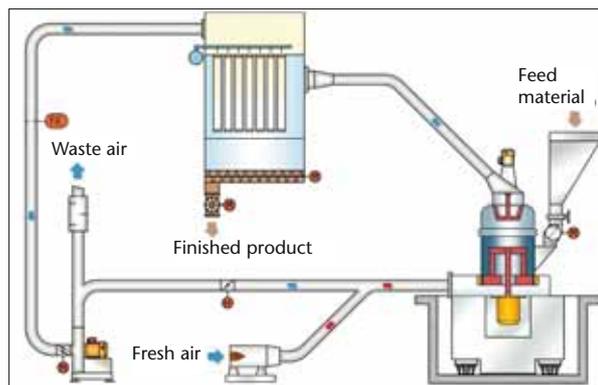


Fig. 3 Schematic of a NEA combined grinding and drying plant with a pendulum mill with connected filter

possible. As clays exhibit precisely these properties, grinding always has to be combined with drying. For clay feed moistures to 20 % H₂O, a stream of hot gas is fed to the pendulum mill, which flows through the grinding chamber and dries the product during comminution. Owing to the rotation of the mill rotor with pendulums and upstream shovels, moist and dried clay is constantly mixed, at the same time the product is dried in a fluidized bed by the stream of hot gas entering the grinding zone from below. Thanks to this spontaneous and effective drying, dry and free-flowing ground material is available directly in the grinding zone so that product caking, adhesion and excessive energy consumption as a result of increased milling can be avoided. The stream of hot gas is generated by a natural gas burner upstream of the mill, which heats an air stream extracted from the environment to up to 700 °C. The flow of hot gas is mixed with the mill air stream so that the air temperature at the entry to the mill reaches a max. 270 °C (Fig. 5).

Fig. 4 Combined grinding and drying plant at ERLUS with NEA pendulum mill with radial air classifier



Sharp upper particle size limitation

To avoid the surface defects described in the introduction, sharp



Fig. 5 Hot gas generator

upper size limitation of the clay powder product is of crucial importance. The dynamic deflector wheel classifier installed above the mill rotor classifies the particles according to the principle of countercurrent centrifugal air classification. Key feature of such classifiers are their separation sharpness.

The maximum size limitation or fineness of the required clay powder depends directly on the speed of the classifier wheel. Accordingly, the fineness can be infinitely adjusted based on the speed of the classifier wheel.

A sealing air system for the gap between classifier wheel and classifier housing avoids particles passing the classifier gap, landing in the product as misplaced and oversize and leading to an unsharp upper particle size limitation.

Measurement and control technology

Precondition for a continuous and stable drying and grinding process with maximum possible discharge mass flow and constant product quality is the monitoring and control of the crucial operating parameters. Besides the usual measurements of under-pressures, temperatures, speeds and motor power consumptions, the process parameters described in the following are of special importance. Modern grinding plants with pendulum mills are designed and controlled so that after changing of the only setting, the classifier speed, the other operating parameters are automatically readjusted to the optimal operating values (Fig. 6).

Air volume flow rate control

In the grinding plant with pendulum mill and integrated classifier, the



Fig. 6 Control, process visualization and process data acquisition

entire function, the product mass flow, the fineness and the drying are determined primarily by the air volume flow rate. A constant air volume flow is therefore the precondition for optimal and effective operation of the grinding plant and a uniform product quality. The air volume flow rate is measured in the ductwork between the filter and fan. The speed of the radial fan is controlled as a function of the air volume flow rate.

Feed-rate mass flow control

Based on control of the apron belt speed of the box feeder as a function of the power consumption of the mill motor, the feed mass flow rate is automatically set to the maximum possible value and the mill supplied with the optimum load. Control is not only crucial for the stability of the process and product quality, but also for avoiding partial load and under load operation.

Hot gas temperature control

For uniform and sufficient drying, the heat flow produced by the hot gas generator is controlled as a function of the mill exit temperature. The air/dust mixture temperature at the mill outlet measures 75–80 °C to guarantee a sufficient gap to the actual dew-point temperature and to avoid condensation in the product filter. The control system is designed so that it can quickly follow variations of the air volume flow rate and feed rate.

With the PM16U3 combined grinding and drying plant supplied by NEUMAN & ESSER to ERLUS, the preconditions for a high surface finish and quality of product are already fully achieved in the first process step, that is preparation.