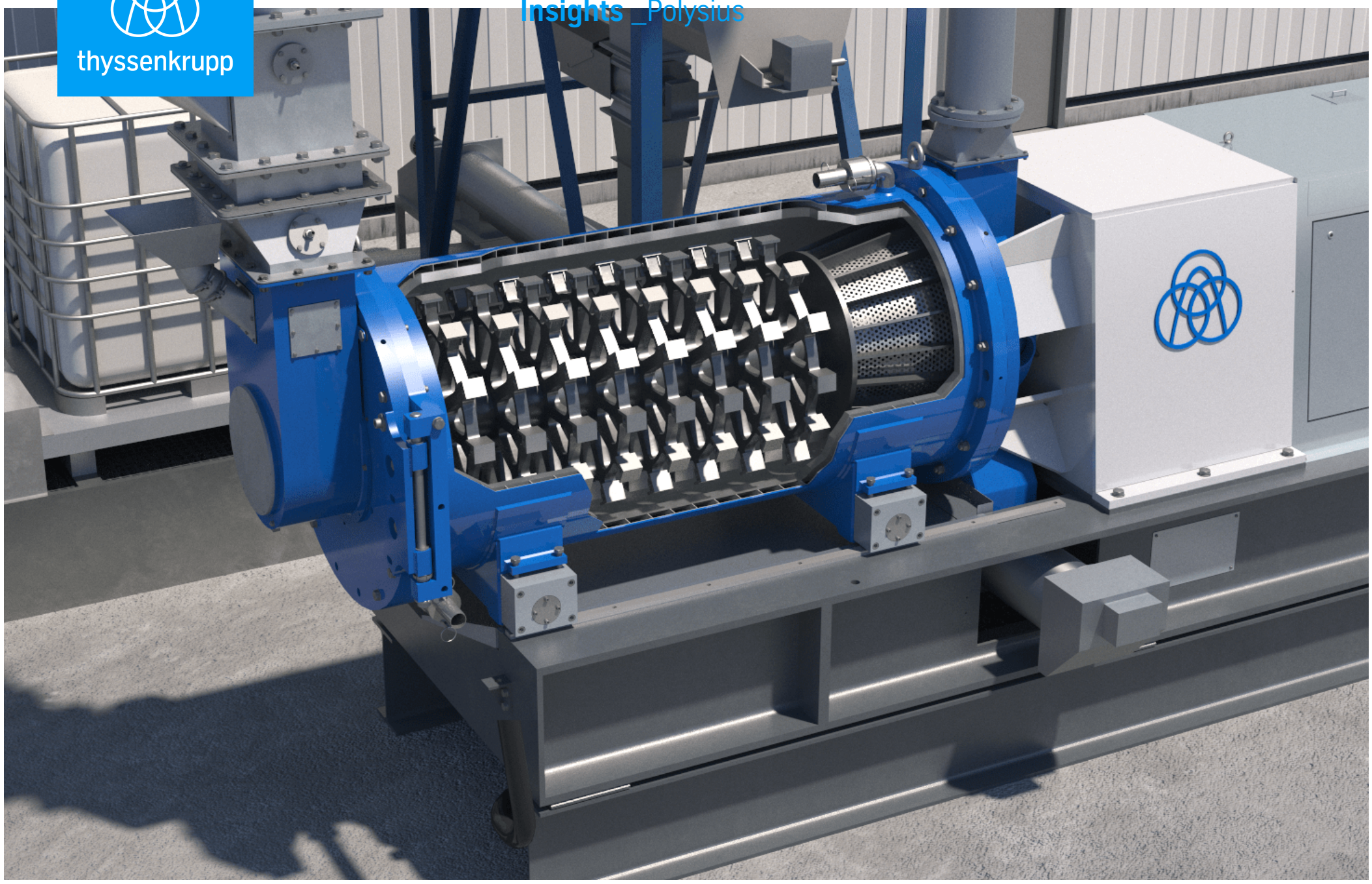


Let’s talk:

polysius® booster mill – the next level in cement grinding?

Reducing the clinker factor without compromising quality and the rising demand for high-performance cements are great challenges for the fine grinding technology used in cement plants. As part of its green cement plant project, thyssenkrupp has expanded its product range with the polysius® booster mill. While one cement manufacturer has already integrated the mill into his existing grinding circuit, several others have

tested the mill since August 2020 and are checking results in terms of specific business cases. Michael Wilczek, Senior Data Specialist and Dr. Guido Kache, Senior Process Engineer inform about the design of the new mill and the results obtained during the operation of the pilot plants.

The polysius® booster mill should be the next level in cement grinding. You developed this new technology together with Netzsch Feinmahltechnik?

Wilczek: Yes, indeed. After the horizontal agitated bead mill for a wet process (in ore benefication) was established decades ago by Netzsch Feinmahltechnik, the polysius® booster mill as an application for a dry process has been jointly further developed by Netzsch Feinmahltechnik and thyssenkrupp. Small scale tests and an industrial pilot plant are proving that the new solution covers a wide range of application scenarios and objectives of cement manufacturers.

Please describe the design of polysius® booster mill. What distinct features does it have?

Dr. Kache: The working principle and the pilot installation, the first adaption of the original design to the dry cement process are illustrated in figure 1. A series of grinding tools mounted on a shaft are rotating at a high speed, stirring the grinding media (beads) inside a fixed shaft. Size of the grinding media typically varies in a range of 4-8 mm. The grinding tools reach a tip speed of 5 times the critical speed, rather creating a constant cloud of grinding media than a revolving mass of rolling and falling balls inside the rotating shell of a ball mill, at a maximum of 0.7 times the critical speed only.

In order to improve the air and material flow, several modifications and optimizations had to be implemented, while keeping the working principles in place.

Wilczek: The mill accepts a maximum particle size of about 0.5 mm for hard and up to 4mm for softer materials. One typical characteristic of the mill is the high energy density, 10-20 times higher compared to a ball mill, resulting in a very compact design. The high energy density in the small grinding chamber requires a fast material transport. Accordingly, a high air suction is needed to get the product transport through the mill.

With these features in mind, further modifications and add-ons for an optimal dry process, including a modified feed inlet, a new agitator design, and a new airflow concept with an adapted filter, were necessary.

In a combined flowsheet within an existing grinding circuit, there are several possibilities. Two examples are shown in figure 2.

- The left example shows a 2-chamber ball mill with mechanical material discharge in closed circuit with the separator. A splash box introduces the material into the air flow to the separator. A part of this material is redirected towards the new mill for grinding and afterwards fed back into the circuit.

- The integration into vertical roller mill systems is also possible (see right figure). For example, part of the finished product can be ground finer to improve the cement properties. Alternatively, separator grits can be used as feed material.

Two pilot plants were operated in Turkey and Germany. What are the results?

Dr. Kache: In August 2020, a highly flexible small scale trial plant (100-600kg/h) was commissioned at the R&D facilities of thyssenkrupp's cement technologies division. Ever since, it has been in operation continuously with numerous tests from CEM I, CEM II/A and B cements, to activated clay/LC^3 products, in separate and in co-grinding. Three first stage mills (ball mill, HPGR, VRM) can be connected and operated in different operational modes.

As mentioned earlier, an increasingly attractive scenario is the clinker factor reduction. In order to compensate for the loss in early strength from the lower clinker content, a partial stream of the first grinding stage is ground to a high fineness in the booster mill. The results of just one out of several trials– in this case using a partial material stream from the separator grits – show that (at least) the same cement quality and volume with 6-12 percentage points higher limestone content. A further target could be to securely achieve a 42.5 R level with 20 MPa 2d strength, while maximizing the possible limestone content.

Wilczek: Already in 2017, a pilot installation was commissioned in a grinding plant in Turkey. It was operated in fly ash grinding for two years, with convincing results in product quality and energy efficiency. In the second half of 2019, it was installed in a grinding circuit of the integrated cement production, in order to achieve an increase in production and cement quality. Two main results of the trials were:

Production increase: The CEM I 42.5 N cement production was increased by some 20 percent, up to 56 from 45 tph, still at low utilization of the available of power. Furthermore, a higher compressive strength at nearly the same Blaine surface area indicates an additional potential for production increase by adjusting the cement quality. **Quality improvement**: By switching on the new mill, the compressive strength of the cement was able to meet the CEM I 52.5 R requirement, while maintaining the original production rate. The starting point was the CEM I 42.5 R at a rate of 38 tph.

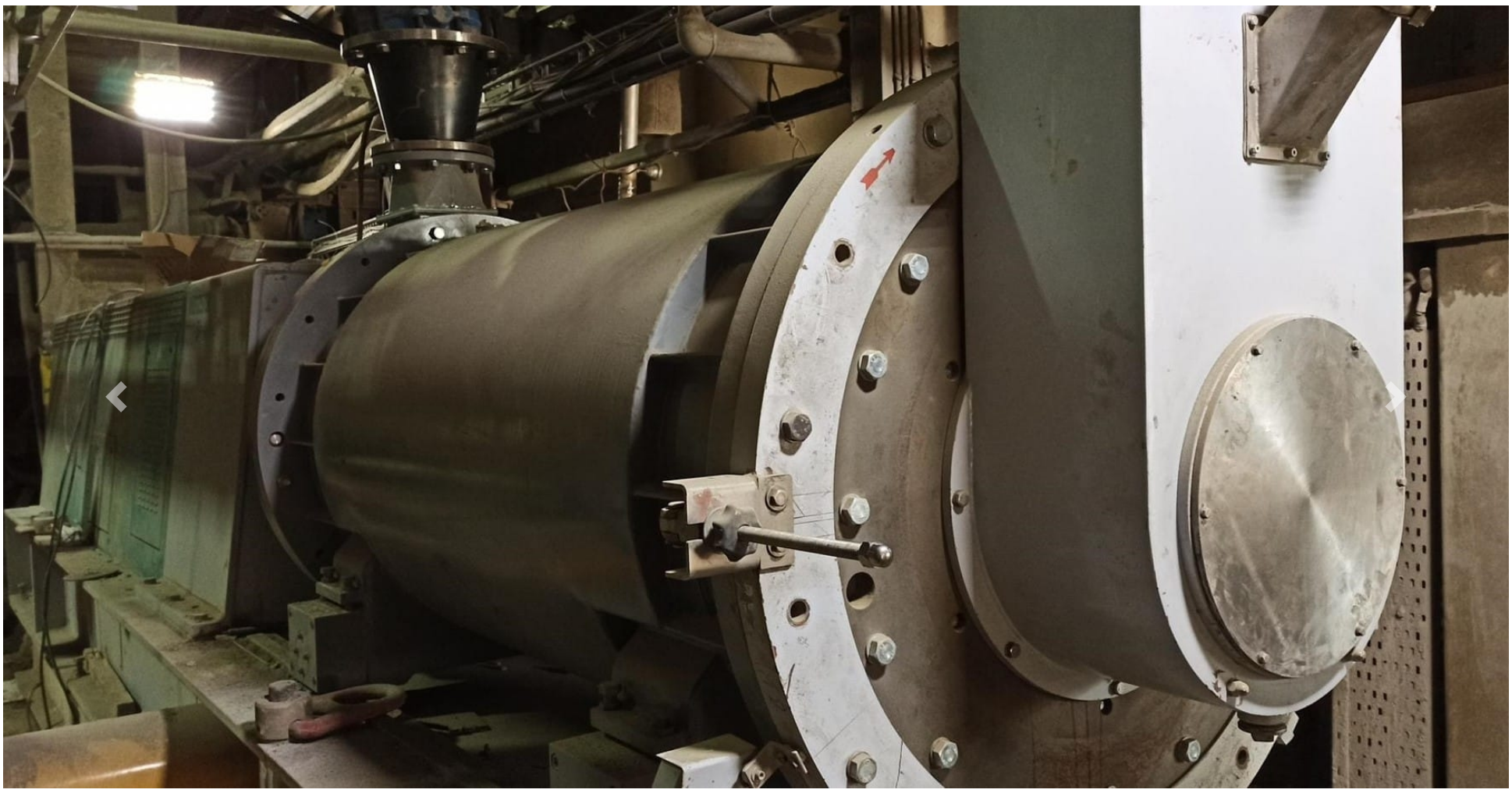
Quality increase is achieved by a more beneficial particle size distribution and possibly a mechanical "surface activation, since the increase in strength cannot be explained solely by the changing PSD, and will be further explored.

Dr. Kache: A crucial question for a broad industrial application was the wear on the equipment, considering the high energy density inside the grinding chamber. However, for the pilot installation totaling >2,000 operating hours were evaluated and very little wear was observed. Therefore, an uptime between maintenance intervals at least matching those of ball mills is currently expected. Replacements of wear parts, liners and grinding tools, can be executed within one shift.

What impact does the polysius® booster mill have on the customer's revenue and profit?

Wilczek: As mentioned before, the range of application has been broadened with the trial and pilot plant results. Possible volume and portfolio changes can be calculated in a detailed individual business case. This was done for the main scenarios, considering an average portfolio and prices in the German cement market (see figure 5).

Dr. Kache: Obviously, any combination of scenarios is also possible. Other advantages add to an attractive business case. One is the very limited downtime of ongoing operations during installation. The high energy density results in a very compact and relatively light weight design, increasing the probability of an installation option inside existing structures. Therefore, also civil and structural works are at a low level, leading to a low additional investment for the tie-in to existing circuit.



Pilot installation and first adaption of the original polysius booster mill design for the dry cement process.

The bottom line: Recent trials show that the performance of the polysius® booster mill system is quite promising for a range of applications and evolving challenges to the cement industry. Several trials with materials are in progress and are refining and adding to the first results and indications. An expansion into cement-related materials like fly ash, slag and calcined clay can also be considered. Obviously, the technology has not yet been established in this broad range of applications, so several trials need to follow and are currently ongoing. Current economic challenges are not calling for investments beyond the absolute urgent necessities. However, market changes often evolve out of crisis situations. In this respect, for some market

segments and companies, the call for a next level in grinding solutions may just be coming at the right time to prepare for the next market changes.