Axel Jahn and Frauke Kretzer, Pollrich GmbH, explore the design, layout, and maintenance of heavy duty industrial process fans, with particular interest in energy efficiency.

Introduction
Cement is the most widely used construction material, playing a key role in various industrial sectors. Cement is one of the most important materials in building construction activities; our modern society...
would be unthinkable without it. However, the manufacture of cement is a very demanding process, with several critical production steps. Harsh environments with abrasive and caking media set a constant strain on all components, including industrial fans and blowers. Furthermore, cement plants are often located in regions where sophisticated maintenance and repair is scarcely manageable. Therefore, it is key that all elements of industrial fans are robust, low-maintenance, and have longevity enough for the entire cement manufacturing process.

Centrifugal fans (single and double side suction) are widely used in the cement industry for conveying, exhausting, dedusting, cooling, and fresh air supply, as well as in the kiln combustion and cooling process and the clinker cooling process. The fans must withstand high temperatures of over 450°C in harsh conditions. High dust loads and sticking or wearing media are a challenge for all components of industrial fans, particularly the moving parts. The highly abrasive particles in dust-laden gases can lead to material fatigue and, at worst, to complete system failure. Therefore, a well thought-through design is required, as well as experience in the construction of industrial fans.

“Wear-protection, gas tightness, and a low danger of caking are essential factors for industrial fans in the cement production process,” said Axel Jahn, Managing Director of Pollrich GmbH in Germany. “To produce first class cement, fans must be designed to avoid the imbalances caused by caking and wear, even at high temperatures.”

Pollrich, with its expertise in industrial fans, has proven experience with the high demands of the cement industry and is contracted in many high-profile projects. Early in 2018, for example, Pollrich completed a contract for approximately 100 fans for a cement plant in Saudi Arabia, shortly after it had finished a large-scale assignment for a big project in Qatar.

“For many years, we have been focusing on centrifugal fans for the cement industry, always considering its very high demands,” Jahn continued. “Our personnel in fan design, engineering, and production, as well as our service team, have a lot of process know-how, combined with a deep knowledge around the fans. That is why cement manufacturers trust us as a reliable partner all over the world.”

Experienced and reliable partners are most important in the cement industry. Aside from fan production, there are many administrative tasks that must be fulfilled, such as export handling, customs checks, logistic organisation, and documentation. Given that many cement plants under construction are in remote areas and less developed countries, this is also an enormous challenge.

### Fan design

Fans used in dedusting and conveying applications, for example those used in raw meal handling, must withstand bone-dry, sticky dust. Raw mill fans are mainly used for conveying dust and raw meal, although they can also be used as raw mill exhaust fans. To produce 1 t of clinker, more than 2 t of aggressive and sticky exhaust gases must be extracted by the raw mill exhaust fans.

Imbalances caused by caking dust cause many problems, such as complete bearing failure on fans and drives, as well as severe vibrations that have a heavy impact on the entire construction, even into the foundations. Specially-designed blade geometries help to reduce caking. An optimal aerodynamic
construction and the ideal balancing of the impeller are important to ensure the best performance of the fan. The selection of a suitable blade design is required. This will be a design with an appropriate inlet/outlet angle, according to power consistence, a straight blade design and/or the selection of a heavy-duty design, such as an impeller between bearings according to the mass of dust or mass of the impeller, and the correct shape and angular position of the impeller blades, as well as other important factors. Other criteria that have to be considered are the Reynolds number, humidity, polymerisation, angle of impact, and chemical adhesion. The different repose angles of the various dusts must also be taken into account.

For an optimal performance, the blade angle should always be larger than the repose angle. The typical repose angle of gypsum and cement is 25°, of sand and gravel is 30°, and of ashes and cellulose is 45°. Selection of the right blade design, according to the peculiar process and the respective types of dust, is therefore vital for the lifetime of the impeller. A well-thought-out blade design helps to increase its lifetime significantly.

Computational fluid dynamics (CFD) and finite element analysis provide impeller circulations. In special cases, a detailed analysis of particle streams can be calculated and optimised by the use of CFD only. Predictions on the build-up of dust may help to select matching geometrics, avoiding imbalance as much as possible.

For wear protection, the type of dust particles should be considered, as well as the average dust particle size allocation, because particle size significantly impacts surface wear. Special blade designs and tungsten-carbide coating allow wear protection, even in the harshest conditions. The combination of long-lasting field experience with thousands of installations over the last 90 years, together with predictable mathematical models used in CFD, enables an understanding of where dust particles create the highest wear on impeller and casing. This knowledge makes it possible to select and apply the most appropriate wear-protection covers at the right surface area of the fans, maximising protection and lifetime, while minimising protection costs.

Gas tightness and explosion protection (according ATEX, EEx, and API) are ensured by the use of special shaft sealing systems. Particularly in hazardous areas, where flammable gases and dusts must be conveyed, special measures should be taken into account to guarantee a high level of safety for staff and the environment. Labyrinth sealings, with sealing gas, suction gas connection, and grease lock, all help to ensure a gas-tight operation.

Polrich fans for the cement industry are often designed to run at variable speeds. With frequency inverters adapting the drive to actual needs, no energy is wasted and fans can run at their optimal performance range.

“With thought-through drive solutions, it is possible to reduce the energy consumption of the fan significantly,” said Jahn. “In particular cases, a cost reduction of up to 70% is viable.” Another benefit is the noise reduction in partial-load operations. Low-torsion substructures are another focal point. Only a carefully balanced system of rotors, bearings, and base frames induce less vibrations and thus guarantee operational safety, ultimately increasing the lifetime of fans.

**Maintenance and repair**

To ensure the performance of complex centrifugal fans in extremely harsh environments, under rough conditions in remote areas, an experienced fan service is an important factor for reliable plant operation. Well-proven maintenance schedules reduce non-operation periods and guarantee undisturbed premium cement production. Synchronised and preventative maintenance operations, inspections, and an intelligent spare and wear part service are determining factors for the trouble-free operation of cement plants. A complete fan check comprises standard service-works, dynamical rebalancing, laser alignment, and bearing spectrum analysis, if required. At regular inspections, spare and wear parts will be repaired or replaced. High operational requirements may lead to the replacement of wear parts like impellers, shafts, or housings. Through various applications during the cement production process, impellers in particular are enormously strained.

An all-embracing service includes a full examination of all fan parts, a close evaluation of the measured values, all necessary corrections, and an extended report with recommendations, for example to suggest efficiency improvements or other suggestions regarding the fan performance.

Under the demanding process requirements of the cement industry, only highly experienced service teams are capable of fulfilling such strong demands. This includes full service, upgrades and improvements, or the exchange of fans. The skilled and experienced Pollrich Service is on duty worldwide, aiming to always be where it is needed, even in the most remote places and in the roughest conditions. The company’s
experience and operational readiness help to reduce standstill to a minimum and improve overall plant performance significantly. Pollrich not only considers the actual condition, but also carries out predictive maintenance; while everything might be working well at the time of analysis, this may not be the case after another 8000 hours of operation. Predictive maintenance enables customers to minimise shutdown periods and allows for long-term planning.

Conclusion
The cement industry is under increasing pressure, due to strong competition and increasing energy costs. The operation of cement plants, given their large-scale energy demand, is very cost-intensive. Thus, productivity and efficiency during the whole production process is of high importance. A vital factor for overall plant performance is the efficiency of industrial fans.

“The cement industry is characterised by high energy costs, whereof the operating costs of the industrial fans take a huge part. We design and build our fans according to each customer’s needs, always considering energy efficiency and plant reliability,” said Jahn. “The optimum in relation to efficiency and energy-consumption is an important factor for fan construction. One of the largest opportunities for improving energy efficiency in cement production is to lower the energy consumption of the industrial fans.” Reducing energy consumption naturally leads to a considerable cost reduction and also to an equally important decrease in CO₂ emissions.

For more than 112 years, Pollrich has been a leading manufacturer of heavy-duty industrial fans. The company is closely linked to the cement industry and is well-versed in its special requirements regarding efficiency, availability, and the performance of process fans. Well-designed industrial fans and blowers help plant operators to lessen shutdown periods, reduce energy costs, and ensures safe and reliable production, which is vital for the cement production process.

About the author
Axel Jahn is Managing Director at POLLRICHT GmbH. He has decades of experience in industrial fans and blowers and is an expert of industrial fans for the cement industry.

Co-author, Frauke Kretzer, is the Manager of PR and Communications at POLLRICHT GmbH. Kretzer has long-standing experience in B2B marketing in the industrial sector.