

#### KHD HUMBOLDT WEDAG

# Creating value through innovation for the cement industry

For close to 170 years, KHD Humboldt Wedag has been developing innovative technologies for the production of clinker and cement. Many of these machines and processes have become standards in the industry, allowing cement producers to significantly reduce production costs and environmental impacts. In today's very competitive market environment, KHD is still going strong and continues to deliver value to its customers with products for high alternative fuel utilization, low energy consumption, and lowest emission of  $NO_x$  and  $CO_2$ . The company is also looking to tomorrow and the need for the cement industry to decarbonize and digitalize. KHD is geared to deliver innovative solutions for this most challenging future as well.

#### The early history

The history of KHD is the history of an industrial innovator. To trace the beginnings of what would be KHD, we must go back to the golden age of Germany industrialization in the 19<sup>th</sup> century to Humboldt Industrial Plants, named for one of the most famous German scientists and explorers, Alexander von Humboldt. Von Humboldt's work changed the mining industry and provided the spirit of innovation that has defined KHD ever since.

The KHD name emerged in the early 20<sup>th</sup> century, when pioneering industrialist Peter Klöckner formed Klöckner-Humboldt-Deutz AG, which brought together the activities of the iconic companies: Humboldt Industrial Plants, Deutz Motor



Works and his own Klöckner Werke AG. Again there is a great deal of innovation wrapped-up in the history of these famous names: Deutz stepped onto the world stage with such milestone inventions as the "Otto" combustion engine which was invented by Eugen Langen and Nikolaus August Otto. A Pyrorotor<sup>®</sup> installed at a plant in South Korea

As the Deutz part of the business continued to focus on engines, trucks and tractors, so the parts of Klöckner-Humboldt-Deutz AG that grew into KHD Humboldt Wedag focused on the processing of minerals and coals, as well as on the production of cement. On the back of such a rich entrepreneurial record, the company began its exceptional role in the cement industry in the 1950s with the development of the cyclone preheater. The cyclone preheater allowed cement plants to significantly reduce specific heat consumption in comparison to the long kilns and Lepol kilns that were conventional at the time. It introduced the completely new and revolutionary concept of staged-counterflow heat transfer in gas suspension. Because of its obvious advantages, it quickly became the industry standard, and remains the go-to pairing for cement production in a rotary kiln today.

Not long after, KHD were responsible for introducing precalciner technology using highlyefficient flash tube-type calciners, after Japanese inventors developed the so-called RSP pot-type calciners. The flash-tube Pyroclon<sup>®</sup> calciner transferred 90% of the energy-intensive process of raw meal calcination into a much more efficient reactor, thereby cutting energy costs considerably.

KHD continued to bring new technologies to market in subsequent decades, when the company adapted high-pressure roller grinding technology – developed by Prof. Klaus Schönert in the 1970s and 1980s – to the needs of the cement industry. Compared to the ball mills of the time, the roller press reduced energy consumption for the preparation of cement raw meal by more than 40%.



1 Drawing of KHD's old headquarters and manufacturing site in Kalk (Cologne), back in the early 20th century



2 A hand-painted advertisement for "Maschinenbau Anstalt Humboldt" from the early 20<sup>th</sup> century These are the most popular innovations that KHD brought to the cement market. Other innovations introduced by KHD include the short kiln, the static v-shaped separator, and the multi-channel jet burner. The company was also among the first to take-on the cement industry's environmental footprint, introducing the low-NO<sub>x</sub> calciner with staged combustion in 1985. To this day, the company is proud of its innovative spirit, and the company's management and global workforce execute their work in this spirit, day in, day out.

#### Continuing the tradition

KHD continues in this innovative tradition today. Among its most recent product developments, the Pyrorotor<sup>®</sup> and Pyroredox<sup>®</sup> help reduce the envi-



3 A preheater concept drawing dating back from 1952

ronmental footprint of cement production further still. This comes amid growing concern about the industry's emissions.

The Pyrorotor delivers complete burn-out of even the lowest-quality alternative fuels. Based on rotary kiln technology, it features a rotating combustion chamber to ensure proper mixing of the fuel with oxygen-rich tertiary air in temperatures up to 1200 °C. Speed of rotation can be adjusted from 0.3 to 3 rpm for ultimate control of combustion conditions and to enable long residence times of up to 10 minutes. The use of recuperated hot tertiary air also means that no additional burner is required. There are currently eleven Pyrorotor installations with more on the way in regions such as South Korea, China, India, and Turkey.

The Pyroredox is installed between the kiln inlet and calciner to separate reactions that would usually occur concurrently in the calciner. In the first stage, kiln exhaust gases are fed into the Pyroredox. This prevents complete combustion of the fuel and creates CO-rich conditions within the Pyroredox loop. Extended fuel residence time of about 4 seconds in this CO-rich atmosphere allows the CO to react with the NO<sub>x</sub> in the kiln gases, reducing them to CO<sub>2</sub> and N<sub>2</sub>. The remaining lean gas is fed into the calciner, where classic oxidation of the lean gas and tertiary air takes place, ensuring calcination of the raw meal.

This staged combustion delivers significant and permanent reduction of  $NO_x$  emissions, allowing very low  $NO_x$  emission limits to be realized, while lowering the ongoing maintenance costs associ-



4 An advertisement for KHD rotary kiln installations

ated with catalytic SCR-systems. As such, it has proved particularly popular in China, which has some of the tightest  $NO_x$  emission regulations in the world. Despite its huge impact on  $NO_x$  emissions, Pyroredox has no negative impact on clinker production capacity, fuel consumption, or power demand of the cement plant.

#### A global company with its heart in Germany

Through a network of companies around the world, KHD is close to customers in all major global markets and can fulfil all regional requirements, quickly and easily. These several KHD companies cooperate seamlessly with each other, thus providing the optimal use of competencies and capacities that is critical to success in the cement industry.

Although the company network has evolved into a modern system of distributed competencies, the company's heart is its Center of Excellence (CoE) in Cologne, Germany. The business unit unites KHD's knowledge and experience and delivers all process, design, plant, and automation engineering services for the group. KHD employees work in modern, cross-functional teams to develop the best possible solution for each and every specific project. In doing so, they consider all multi-stakeholder requirements – from productivity to CAPEX and OPEX, reliability and maintainability, safety and ease of operation.



The technologies and solutions developed at KHD headquarters are made available to the global cement market via the company's sales and services team. Alongside technical excellence, customer service is the second key focus for KHD, because the company understands that success in the cement industry comes on the back of long-term relationships with customers. Regional customer service centers are thus located close to customers in all markets of the world. Recently, the markets in India and China have become very dynamic. KHD 5 A Pyrorotor<sup>®</sup> installed at a plant in Europe

6 A Pyroredox<sup>®</sup> installed at a plant in China



has further extended its strength there by setting up organizations with additional engineering, procurement, and manufacturing capabilities. Especially KHD's Customer Service Center in India has seen a consistent growth over the last years. This allows the company to best serve the needs of the fastest growing cement market in the world.

KHD also understands that the cement industry is too small to forget any malperformance. The company offers a wide range of services to the cement plants, covering necessities such as original spare parts and inspections, as well as consulting and optimization services that support sustainable profitability. KHD experts can perform audits, undertake feasibility studies, and prepare modifications and retrofits to optimize any plant to the ever-changing process and market conditions that define the cement industry.



7 The KHD headquarters in Gremberghoven/Germany

#### R&D is the DNA of KHD

RED lies at the core of the Center of Excellence. Here, new products and upgrades are developed from first concept to commercial reality. The engineers are tightly connected to the real-world challenges faced by cement plants and serve projects in close cooperation with the company's service and project execution managers. This ensures that KHD innovations are always practical and reliable.

As machines and processes of the size required in the cement industry cannot be built in a lab or test center, the development of those innovations has largely been transferred to the most modern methods of computational simulation. KHD specialists have developed a range of simulation tools for various purposes and collaborate closely with internationally-renowned experts in their specific fields.

KHD also operates a Technology Center that is also equipped with a raw materials testing laboratory, where varying materials and feedstocks can be tested to determine their characteristics. The information gathered is fed to the company's processing engineers for use in the development of best-possible process and product designs. As raw materials and feedstocks change and become more variable in future, this capability is expected to play an increasingly valuable role, underpinning new product developments.

KHD understands R&D to form the core of its business model. Customers expect KHD to be a technology leader in the cement industry, offering the most advanced machines and processes. That's why KHD has set up its organization to take optimal benefit from the increasing knowledge around the world, and encourages close collaboration among the several entities of the group under a common technological leadership of the Center of Excellence in Cologne/Germany.

#### Into the future

The last three decades for equipment suppliers to the cement industry have been ruled by intense price challenges. The focus on technological development that marked preceding decades has generally decayed for all technology-driven suppliers, and room was given to cost leaders, who offered general technologies at low prices. While this is not unusual in mature markets, the new needs of the cement industry now call for technological innovation again. KHD understands that the future of the cement industry will be defined by the need to decarbonize and digitalize – and it is committed to supporting the industry through this transition.

For example, KHD ProMax<sup>®</sup> is a suite of cloudbased digital solutions that connects to and delivers real-world optimization of cement plant equipment and process. Integrating plant data with state-of-the-art digital twin and machine learning technologies, KHD ProMax delivers benefits that include:

- » Increased plant throughput and production stability
- » Reduced downtime and lower spare part costs
- » Intelligent maintenance workflows
- » Prescriptive dynamic maintenance optimizing service life
- » Remote action through augmented reality from anywhere in the world
- » Improved business planning for maximum profitability and sustainability

KHD ProMax thus offers next-level improvement in cement plant performance. But the company is also aware that the challenges ahead do not allow any pause in innovation. This creates a business environment that KHD is optimally set up to serve. After all, innovation is a part of the company's DNA. And with a committed main shareholder in place, KHD is revitalized and intent on reclaiming technological leadership among cement OEMs.



8 Jaypee Himachal cement plant at night

The main shareholder in KHD is AVIC International Beijing Co. Ltd, a member of AVIC, one of China's leading industrial corporations. This combination of KHD know-how with the strengths of AVIC will be instrumental in the rapid technological developments demanded by the market.

Although the specific market requirements vary by regions, the main trends are clear:

- » Increased production capacities to deliver economies of scale
- » Lower energy consumption
- » A reduction in harmful emissions, such as  $NO_x$
- » Decarbonization

These challenges – and especially the last – will require a range of technologies such as solutions available from KHD to maximize use of alternative fuels up to 100% thermal substitution rates, and to deliver very high-efficiency grinding plants. In addition, KHD is working on high-level plant automation, which optimizes plant operations autonomously by leveraging machine learning with expert knowledge. The company is also committed to the development of products and processes that will allow the decarbonization of the cement-making process, which is expected to be enforced from 2030 onwards.

#### People - the driving force of the company

Despite all the new technologies and tools to facilitate engineering, KHD knows that its real assets are the knowledge and experience of the people who work for it. Even today, the cement business is driven not only by technology and price, but also by human relationships and cooperation. KHD is proud of its exceptionally low staff turnover: many employees have been with the company for more than 25 years.

Having developed from a former industrial trust of the golden age of German industrialization into a lean company of less than 1000 employees today, the hierarchical structures in KHD are flat. The management board overlooks group activities but also provides hands-on input into projects and activities if necessary. Local management of Humboldt Wedag units in Germany, the USA, India, and China lead their entities in close collaboration with group management and their department heads. A hands-on mentality and effective communication at all levels of the company ensure flexible and target-oriented solutions for the mutual benefit of KHD and its clients.

#### Jianlong Shen, CEO of KHD Group

"Innovation by tradition" is the best description of KHD's history over the past one and a half centuries. As a leading technology and service provider, we will continue to enrich our state-of-art product and technology portfolio to serve our clients and contribute to a better, greener, and more efficient future.

#### Matthias Mersmann, CTO of KHD Group

KHD has always been a technology leader in its genes and business model. We will continue to deliver that value to our clients, especially in the transition to decarbonization and digitization.

#### Matthias Jochem, COO of KHD Group

KHD project management and execution methodology is always based on a partnership approach with our clients, cooperation partners, and suppliers. Our primary commitment is to deliver the project on time and to specified technical performance. But the true excellence of KHD materializes when it comes to overcoming obstacles and changes – which are common to large investment projects – in a constructive and fair manner.

#### Jürgen Luckas, CFO of KHD Group

Like any other company, KHD wants to make a profit. Still, profit-making is not our only target: we also want to add value to our customers and help achieve environmental targets.

#### André Sybon, MD of Humboldt Wedag Germany

Throughout its history, KHD has been the leading innovator in the cement industry. Now, in response to fundamental shifts in market demands relating to decarbonization and emission limits, we have the opportunity to introduce a new round of innovation, such as the Pyrorotor<sup>®</sup> and our latest AI development, KHD ProMax<sup>®</sup> RTO, which meets the needs of our customers in a rapidly evolving world.

#### Rainer Krüper, MD of Humboldt Wedag Germany

KHD's market, especially in Europe, is increasingly asking for EPC solutions. Fortunately, we have already carried out many EPC projects and, together with AVIC, are able to offer customers complete solutions. Depending on requirements, main components are still built by KHD with additional equipment engineered and supplied by AVIC.

#### Wolfgang Pajonke, MD of ZAB Dessau Germany

KHD offers customer-oriented solutions and assists its clients through every stage of a project. It always starts with feasibility studies and meticulous project development. That way, we can meet any project requirement, and guarantee the design and delivery of sustainable, efficient, and mostproductive cement plants.

#### Ashok Dembla, MD of Humboldt Wedag India

Humboldt Wedag India is a reliable partner to the Indian cement industry as it works toward the goals of the Cement and Concrete Roadmap 2050 for Net-Zero Concrete. We are committed to building a more sustainable world and forge close connections with our customers to support greater use of clean technologies, such as renewable energy, novel cements, and more efficient production systems.

#### Dwayne Holland, MD of Humboldt Wedag USA

KHD not only leads when it comes to products; we are also a project integrator. With a local market presence for project execution, we can meet customer needs for anything from small upgrades to full plants. This includes products and projects, such as limestone cement conversions, alternative fuels, and clay calcination, that are targeted toward the goals of the PCA Roadmap to Carbon Neutrality. www.khd.com

As part of the Cover Story in this issue, Matthias Mersmann, Chief Technology Officer at KHD, answered some very topical questions about technological developments in the cement industry in an interview with the Editor-in-Chief of ZKG Cement Lime Gypsum Dr. Petra Strunk.

#### MATTHIAS MERSMANN, CHIEF TECHNOLOGY OFFICER AT KHD

## Huge challenges and everybody is involved

#### What are the current challenges of the cement industry?

Good question, I think we all know the hot topics of our industry. These days it is the question of decarbonization, the main topic also in a lot of other sectors. It is a huge challenge, and everybody is involved!

#### What solutions does KHD offer its customers in order to be well positioned with regard to decarbonization in the future?

What solution works for which client is depending on a lot of factors: what kind of raw materials are used and what technology is currently installed, just to name two of the most important ones. We work intensively in our R&D department to develop new technologies which will help with decarbonization in the next decades. Already today, we provide various solutions that significantly reduce  $CO_2$  emissions by using one of the following levers: replacing fossil fuels with alternative fuels, producing cement with significantly reduced clinker ratio through the use of calcined clay, and a variety of other solutions that increase the thermal and electrical efficiency of existing cement plants. These are all effective methods to reduce the carbon footprint of cement production already today.

#### ... and probably also the manufacturing costs?

Correct. Thanks to increased efficiency and other improvements, the production costs are also reduced. This is very elegant. If you know that your



production costs are directly related to your energy costs, be it electrical or fuel energy, then you can kill two birds with one stone. For example, when you opt for energy-efficient roller presses or technologies that substitute 80+ per cent of fuel energy to be used in the form of alternative or biogenic fuels, you will reduce your costs and your carbon footprint at the same time!

### Could you give us a few examples for major projects, which KHD is currently working on?

We are very busy these days and we see this as a reflection of the development in the market. Clients are actively asking for modern technologies and upgrades. We are very much involved in projects that increase alternative fuel usage. Our Pyrorotor<sup>®</sup> is much asked for because it allows to substitute nearly 100% of fossil fuels with alternative ones. Then there is also a strong demand for KHD roller presses and grinding technology that allows much lower energy consumption. Our grinding plants also enable the admixture of slag, fly ash and other Supplementary Cementing Materials (SCMs), which is another strong lever. And calcined clay

plants are obviously also a hot topic. All these projects underline, how much solutions KHD can already provide today to significantly reduce  $CO_2$ emissions.

When we look into the future – maybe the next 10 to 15 years – what are the most important tasks for the cement industry as well as for the equipment suppliers? The years 2033 and onwards will define an era which will be very different to today's industry in many respects. If we look at the roadmaps which have been published by cement producers, energy agencies and others, we find a sharp distinction between before and after the year 2030. Before 2030, we will mostly continue to utilize technology, that is already available today. After 2030, we must involve technologies that are able to completely decarbonize the entire production of cement. That means the "big step" is still ahead of us.

Matthias Mersmann, thank you very much for these really interesting insider comments and I am eager to see the future. In conversation: Matthias Mersmann, Chief Technology Officer at KHD and Dr. Petra Strunk, Editorin-Chief of ZKG Cement Lime Gypsum

