Innovative Heat Treatment Installations for Novel High-Performance Ceramics, Modern Powder Materials of the Highest Quality as well as Recycling Processes

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Thanks to the special properties of ceramic materials and the possibilities for their combination, which differ significantly from other materials, a wide range of potential applications is open to technical ceramics. One segment from the portfolio of technical ceramics are the novel high-tech materials, otherwise known as advanced or functional materials. Many of these novel materials are used for electric energy storage, drive technology (e-mobility) as well as in smart phones and computers. Electric energy storage is a key building block in the sustainable design of our future energy supply. In this context, lithium-based batteries for automotive engineering should be given special mention. According to the level of knowledge today, this type of battery provides the optimum necessary energy storage for automotive engineering and offers the most favourable ratio of battery price to energy density.

Introduction

The above-mentioned vigorously growing markets are demanding ever more, smaller and more powerful energy storage units with high energy and power density. The acceptance of e-mobility is closely tied to the range and costs for energy storage. Another aspect is the current diesel emissions debate, which will ultimately bring an increase in the market share for electrically powered vehicles.

Riedhammer is working continuously on the development of kilns and furnaces as well as thermal processes for these materials, as in the high-performance materials sector the potential of technical ceramics is still a long way from being exhausted and development has only just begun [1].

Thanks to synergistic effects and cooperation with partners in the industry, Riedhammer is always able to support customers all over the world and help them meet their challenges.

Riedhammer develops and realizes specific solutions geared to concrete, real customer and material requirements. This technical, ecological and economic attitude dominates the entire development phase, continues in realization/ manufacture and finds its ultimate destination in installation and commissioning. Every installation is designed and developed as a customer-specific project, as every installation meets concrete requirements of the partner and the process and is based on an individual concept.

In the design of the installations, particular attention is paid to the complex chemical composition of the novel materials and variety of chemically different products which very often, for production-related reasons, have to undergo the same thermal process.

As a result, a large number of chemical reactions take place during thermal treatment. With regard to the furnace engineering used, these reactions become more and more critical and challenging with increasing temperature.

Temperature measurement and control are therefore assigned an important role. To meet the high product quality requirements for high-performance materials, Riedhammer works with thermocouples and pyrometers to ensure temperature regulation in rotary furnaces. Temperature regulation over the furnace cross-section, but especially over the length of the furnace is of crucial importance for the product properties after the thermal process.

Depending on the tube’s direction of rotation and therefore of the product relative to the heating and the position of the temperature measurement, the individual temperature control zones can be regulated and controlled precisely over the length of...
The furnace (Fig. 1). With the Riedhammer lance system, the actual temperatures near the product can be measured dynamically and used in the adjustment of the controller. A key aspect in this plant engineering is the treatment of flue gases in response to the growing sensitivity to any environmental impact.

Plant engineering at Riedhammer comprises the installation and engineering of plants, the provision of expert know-how for process engineering as well as energy- and environment-focussed considerations. Naturally, all Riedhammer plants and their peripheral components comply with statutory requirements.

Plant engineering also includes the entire project development, project planning (Fig. 2) and realization. This is rounded off after completion of the commissioning and optimization phase and handover to production by comprehensive service and maintenance management.

**New plants for recycling and special processes**

Over the last few decades, besides classical waste incineration, a wide range of alternative processes has been developed. The objective of these developments was the treatment of waste with methods to maximize the yield of recyclables and produce reusable resources. Moreover, there is a growing need for these resources on account of global demographic development and the increasing shortage of resources coupled with increasing costs.

A special role is played especially by pyrolysis and plants for the recycling of recoverables. These plants are not only used for the generation of energy and the degradation of chemical (hazardous) constituents, during this process they recover valuable resources at the same time. Behind this stands sustainability as the fundamental concept. Pyrolysis can be described as thermal decomposition with the objective being up to complete dissolution, the thermal decomposition taking place in a low-oxygen / (almost) oxygen-free atmosphere. Pyrolysis is used primarily in maximum-gas-tight rotary furnaces in the processing of used tires, production of carbon black, treatment of sewage sludge, recycling of battery materials and solar modules or generally of waste electrical and electronic equipment, disposal of plastic waste, etc. Riedhammer can draw on many years of experience in this field.

Pyrolysis processes differ fundamentally in process control. With direct current operation, the reactant and the pyrolysis gas are fed on the same side and taken off at the other side of the rotary tube.

In contrast, process control in counterflow allows the pyrolysis gases to be taken off on the feed side of the reactant while additional flushing gas can be fed in counterflow on the discharge side of the solids. Depending on the process gas control, different proper
of no return” prescribed for every runway and type of airport further out. Fig. 5 shows some typical images of foam glass products from Riedhammer plants. Typical plants for the realization of such processing applications are indirectly heat-ed rotary furnaces (Fig. 4), gas or electrically heated tunnel kilns with belt, roller (Fig. 6) but also with kiln car transport (Fig. 7). For further useful information on the different types of Riedhammer furnaces for the heat treatment of highly developed materials, the authors refer readers to the paper [2].

Control and regulation concept/process control and documentation

To respond to the ever growing requirements of the customers with maximum flexibility and functionality, Riedhammer is exploring new avenues in respect of control, regulation, but also the scope of functions of conventional regulation and control concepts in electrical equipment. State-of-the-art EMSR systems are part of the standard equipment at Riedhammer. Programmable logic controllers (PLC) ensure precision of the product are achieved. The flushing gas forms together with the emissions of the product the pyrolysis gas, which can be extracted from the inside of the rotary tube by means of an extraction system. The pyrolysis gas is fed for processing in different flue gas treatment processes. In these treatments, the energies are generally removed from the pyrolysis gas or it is transformed into a different physical state (pyrolysis oil). It is then fed to the plant as a fuel, e.g. for heating, or to other plants. To avoid emissions and the undesirable intake of air into the process, Riedhammer offers various proven sealing systems, which are used at temperatures up to 750 °C and an operating pressure of max. 30 mbar maximum. The gastight designs of Riedhammer rotary furnaces and the sealing systems available work with a wide range of atmospheres such as, for example, H₂, N₂, endogas but also in oxygen. Huge quantities of used batteries, also on the basis of lithium as well as photovoltaic cells, are now collected for disposal, and the valuable materials contained in them must be recovered or made safe in thermal processes. Besides the above-mentioned materials that can be recovered in complex thermal processes, large volumes of used glass are collected worldwide. After recycling, the usable part is fed to the manufacture of new glass. The remaining part of used glass is processed in a recycling process to novel materials. Here too, Riedhammer offers a wide range of equipment in its portfolio and has sufficient experience in the realization of such applications. For processing used glass, typically gas or electrically heated tunnel kilns with belt transportation (Fig. 3) and rotary furnaces (Fig. 4) are used. Here the waste glass is ground, mixed with expanding agents and then foamed in the thermal process. The foam glass is then used either as foam glass gravel, foam glass beads or as foam glass bricks and blocks in the building materials industry as insulating material, as filler or for acoustic purposes. The latest application for this material is in the lengthening of runways at airports, to push the “point of no return.”
Riedhammer excels with user-friendly solutions with maximized plant availability, in which the plant operator and his products are at the focus. Riedhammer customers get the entire value-added chain from design and manufacturing to production-accompanying commissioning, including the complete automation technology as well as maintenance and service from one source. The standard that Riedhammer has set itself is to provide customers with plants that guarantee maximum quality that can be reproduced at any time.

Anyone who wants to survive in the market has to be innovative and flexible, but also systematically live and implement quality assurance processes and support its customers with extensive service management. This also includes the process known under Industry 4.0. Industry 4.0 refers to the networking and digitization of the kilns and furnaces with the entire production and maintenance process [3].

All Riedhammer furnaces supplied are already optimally prepared for future requirements or provision for these, insofar as they are already required, has already been realized in the plant. The integrated solutions from Riedhammer don’t end with the production and delivery of a customized industrial plant. As indicated above, Riedhammer also supplies automation and visualization of all safety-relevant processes with the help of fail-safe PLCs.
Service management

Riedhammer service management, consisting of technical support during installation and commissioning, procurement of spare parts, provision of professionals for modernization and conversion work of existing plants (revamping) and the Riedhammer Application Center, ensures customer support with use of the Riedhammer network at all times. This includes, for example, increasing production output, optimizing the firing process and improving product quality. Riedhammer plants can be flexibly adapted to growing and changing requirements.

The production of technical ceramics requires various processes, e.g. drying, calcining, sintering and tempering. Riedhammer can offer a wide range of solutions including peripheral plant components to assure the best possible results for the customer. Besides the range of different furnaces from the Riedhammer portfolio for various processes and products, Riedhammer provides its customers with the option of verifying and developing processes in tests at its Application Center (RAC).

To maintain the utilization and efficiency of the plants supplied for as long as possible, Riedhammer procures and supplies its customers with any original parts required. Riedhammer also compiles plant-specific spare parts lists and can, if requested, check spare part availability or procure compatible spare parts if original parts are no longer available.

Conclusion

With its decades of experience and very extensive range of products, Riedhammer is able to offer its partners the optimum solutions for maximized product quality and efficient production. Riedhammer plants are in operation all over the world and set standards. They are proven performers even with the highly demanding requirements of technical ceramics in terms of specific product requirements for atmosphere, temperature uniformity, heating and cooling curves, lower energy consumption and chemical resistance. Riedhammer is the only supplier worldwide able to offer the entire range of industrial kilns and furnaces for the ceramics industry, the most suitable plant being selected following determination of the optimum firing and installation conditions, independent of the technology and production process used.

The well-known reliability of Riedhammer kilns and furnaces is based not least on ongoing optimization of the functions, such as increasing the production rate, improving product quality and reducing emissions and fuel consumption. The reduction in the energy consumption also impacts the investment and operating costs for any downstream flue gas cleaning systems, which with lower energy consumption and therefore lower flue gas volumes can be designed in a smaller size.

In this connection, an important role is played by the CO₂ tax, which thanks to lower energy consumption can be reduced accordingly. For the market for novel high-performance ceramics, modern powder materials and an array of different recycling processes, the wide-ranging Riedhammer portfolio and the associated services open great potential for further and new development of plant concepts and materials to obtain optimum performance in every respect.

References