Germany

Linn Successful in Industrial Plant Engineering

Microwave technology – Electrically heated HT furnaces – Laboratory furnaces.

Fig. 1 Horst Linn

The roots of the company **Linn High Therm GmbH**, which was founded by *Horst Linn* in 1969, lie in the engineering of speciality furnaces for laboratories and research (electrically heated high-temperature furnaces, induction melting and casting furnaces). In 1979 the company went into the engineering of induction heating plants, microwave and vacuum furnaces for production and laboratories. Shortly after German reunification (1991), the company took over a plant in Bad Frankenhausen, which gave it further capacity for building medium-scale industrial plants.
Horst Linn is an innovative entrepreneur who likes to keep active in his specialist field of high-frequency systems, but is also happy to pass on his management experience by participating on many committees (e.g. Chairman of OTTI – Ostbayerisches Technologie Transfer Institut, VDMA /TPT Board, member of the foreign trade committees of the VDMA and the Chamber of Industry and Commerce, as well as the Asia-Pacific Committee of German Business and Member of Executive Committee of the German Federation of Industrial Research Associations AiF "Otto von Guericke" e.V., Business Angel of the Year 2004).
Especially in industrial-scale microwave drying, Linn has been able to expand its market presence markedly over recent years. As there is a host of research projects focussing not only on drying, but also on sintering with microwaves, we wanted to hear more about the potential of microwave technology from a plant supplier with numerous patents. Horst Linn (HL) summed up his experience from a wide range of applications (ceramics, building materials, glass, refractories, metal, foodstuffs, etc.). The ceramic sector accounts for around a third of Linn High Therm sales and is an important market for the company.

***cfi:** How has microwave technology (drying, sintering) positioned itself in the ceramic-producing industry in recent years?*
HL: Microwave drying has already established itself as the state of the art in certain sectors (catalytic converter substrates, diesel particulate filters). In drying with microwaves, the inverse temperature profile that is characteristic of microwave technology has huge advantages (Fig. 2). As the temperature in the core of the component always rises more rapidly than the surface temperature, for materials with open porosity, expulsion of the moisture outwards is guaranteed not to be hindered by the effects of drying shrinkage, which can lead to cracks. In many sectors microwave drying, however, remains an isolated application (e.g. the drying and redrying of plaster moulds, pre-drying of pressure-cast washbasins, drying of high-voltage insulators, large porcelain figures, ceramic grinding wheels, granulates and powders). Our plants operate very effectively in foundries (e.g. hardening of foundry cores, drying of facing on foundry cores) or for insulating materials (fibre materials, perlite boards). Sintering with microwave systems has not yet become established in industry. But for the debinding of components it can be said that, depending on the size of the components, microwave technology is on the threshold of industrial application.

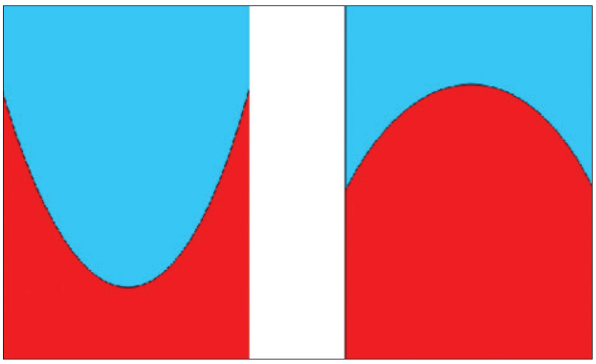

Fig. 2 Inverse temperature profile (right) of microwave technology

***cfi:** What relationships exist between performance of the microwave systems and the size of components or type of material?*
HL: For drying applications, moisture is generally the process-determining factor as opposed to the type of material. Most component dimensions are non-critical, with the exception of extremely large lengths (e.g. rollers) and small sizes and small dimensions (e.g. tapes) because here the coupling properties are crucial. In microwave sintering the type of material (microwave transparency, reflection, absorption and mixed effects) and the product dimensions, however, are crucially important. For very strong and extremely poorly coupling materials, that has an enormous influence.
***cfi:** Can the problems of poorly coupling materials be compensated fully by using higher microwave frequencies (5,8 GHz?)?*
HL: Technically, the 5,8-GHz frequency can at least partially compensate for the disadvantages of poor coupling or/and low product volume. In economic terms, it is usually not possible on account of the

Fig. 3 Rotary kiln with integrated cooling zone (950 °C, protective gas)

disproportionately high costs of 5,8-GHz systems. The price of these magnetrons is multiplied by around a factor of 20. An equally negative point is that their lifetime is only a fifth or less of magnetrons with 2,45 GHz.

cfi: *Where do microwave sintering systems have most advantages?*

HL: On laboratory-scale the essential advantage is the shorter sintering time, with the associated effects such as time savings or less grain growth, etc. Unfortunately, this can only be upscaled to industrial plants to a limited extent. I think that here it is very important to further develop hybrid systems.

cfi: *Is the trend towards hybrid systems?*

HL: Yes, quite definitely. For "low-temperature processes" such as drying or preheating, the combination of microwaves and e.g. hot air is becoming increasingly common. The relative air humidity in the chamber must be minimized and homogenized, and for this a sophisticated system of air circulation is needed. For high-temperature processes, a precision design to match the material processed is required. Hybrid technology is presumably the only economic path to industrial applications. For C-fibre applications, combinations of microwave and inductive heating are sensible.

cfi: *What importance in terms of sales percentage do large-scale plants have at Linn alongside the laboratory furnace range to 2800°C?*

HL: For electrically heated furnaces, they made up a third of sales last year, for microwave technology the percentage was after all just below 70...80 %.

cfi: *Has this resulted in a reorganization in production or sales?*

HL: In our company, technical sales are handled like an integrated process from initial query to commissioning, for this reason we continue to work on an order-specific basis. For the engineering of microwave systems, we have built a new hall in Eschenfelden.

cfi: *For what applications is Linn now building large-scale plants?*

HL: For the drying of ceramic components in batch operation, calcining of ceramic powders in continuous belt furnaces and for heat treatment of metals (titanium casting plants – turbochargers – turbine blades). Linn microwave industrial systems are also used in the animal feed, foodstuffs and rubber industries. There are also interesting solutions for recycling high-quality materials. As we have signed secrecy agreements here, unfortunately I may not say any more on this. The automotive supply industry is also shaping up well. We are receiving an increasing number of enquiries concerning photovoltaics and at last again from nuclear technology.

cfi: *The buzzword "energy efficiency" is not only occupying the operators of thermal plants in Europe. What contribution can the suppliers of thermal industrial plants make to this today? What importance does microwave engineering have?*

HL: Saving energy has always been more efficient than generating energy. As plant suppliers we have always endeavoured to achieve high thermal efficiencies. The end customer must, however, also be prepared to reward innovative plant designs and recognize that it is only possible to maintain further development in industrial furnace and dryer construction from a win-win situation experienced as a partnership. European plant suppliers currently hold an outstanding position on the global market. For R&D we need both money and creative engineers who can realize their ideas. Microwave technology is a "joker" among a range of other technical solutions, which we want to introduce on a wider basis.

cfi: *How does a medium-sized company such as Linn manage to initiate and process R&D projects efficiently, i.e. with a short timeline, to stay ahead in the market?*

HL: We hold 90 patents, which we have so far only used to a limited extent, because they are often innovative fundamental solutions. Only a short time ago we realized a project on the basis of know-how that we evolved back 18 years ago. Important, naturally, for successful market entry is to practise efficient process management.

cfi: *How important is your export business? How do the markets in China, India, Russia and South America rank for you?*

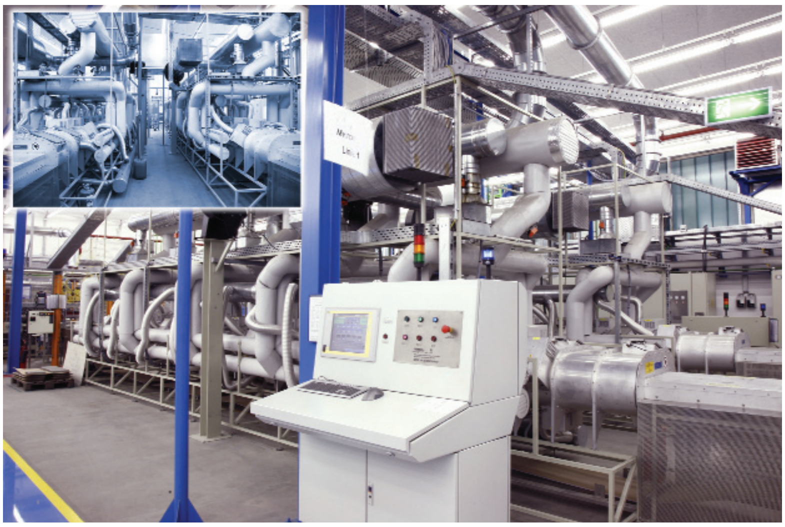

Fig. 4 Continouous microwave belt dryer (50 kW / 20 m)

HL: We export an average of 60 % of our plants. The BRIC countries are all interesting. We have already founded Linn sales offices in Shanghai, Moscow and Kiev. In other regions, dealers work to represent us. We find the development in India very encouraging at the moment. Although our domestic business is going extremely well at the moment, we shall still channel our energy into development of our export markets. But we also need more alliances and partners for application and sales from Germany for new and large-scale projects abroad as a small company like ours cannot afford to do everything itself. The export control regulations are also a time-consuming affair in many markets.

***cfi:** How do you judge the recruitment situation for young professionals in industrial furnace construction?*

HL: The situation is very tight, unfortunately. From my own experience, I know that it is difficult enough to get good engineers and technicians. We have various vacancies to fill at the present. We have to realize that the gap in specialist knowledge between us and important buyer countries is diminishing because of fast learning effects. Only with a knowledge edge shall we continue to score points in key export regions such as Russia, China and India in the long term. In order to remain innovative, we have to become more active in supporting young talents together with colleges, universities and research groups (e.g. FOGI / VDMA).

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