In this figure the high velocity in the fire shafts, the distribution underneath the cover and the increased velocity of the flows towards the pit outlet in the channels is clearly visible. Geometrical design changes have now considerably influenced the conditions in the furnace. Left Figure 13 shows the conventional design, on the right it shows the modified design, whereby the pressure distribution is depicted in color. The solution found here was the reduction of the size of the openings of the saggar bricks located near the pit outlet and their collection in groups. This leads to an increase of pressure towards the fire shafts.

These adaptations led to a desirable equalization of the flow distribution pattern in the section, Figure 14 and, in consequence, to a more even heat-up of the products. The goal to determine potentials for the improvement of the product quality was thereby achieved (flow, heat transmission, energy balance and consumption).

In addition thereto, the mathematical transfer function resulting from the simulation offers the opportunity to examine various section geometries prior to actual construction. This optimizes the baking process and the quality of the products.

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Innovations in the Design and Construction of Ring Pit Furnaces
Already in 1924, Riedhammer developed the first ring pit furnaces for manufactured carbon and has been one of the world’s leading manufacturers ever since.

Baking units of enormous size are required for the baking of anodes, cathodes, and electrodes for the aluminum industry. For example, more than 10,000 tons of refractory material are usually installed in a furnace of average size.

The ring pit furnace is isoperated as a so-called closed furnace which means that each section belonging to the fire train is covered. The furnace is heated indirectly by flue gases, the temperature of which is minutely controlled. Despite the fact that the basic principle of operation has not changed, Riedhammer continuously advances and optimizes the design of this type of furnace. Ring pit furnaces are long term investments, which usually are not replaced by a new plant, but are modified and extended, if deemed necessary. Therefore, it is extremely important to determine and use the potential for improvement of existing plants.

The quality of the products, the overall optimizing of the process, the lifetime of a plant, and the reduction of the maintenance effort are the criteria for the permanent advancement of innovations.

The exact knowledge of the physical processes in the furnace is a prerequisite for the achievement of the above mentioned goals. In order to gain this knowledge theoretical calculations and data acquisition in the furnace itself are necessary. If both results are put in proper relation, a “guideline” for further development is received. It is extremely difficult, costly and involves great effort to measure the required values while the ring pit furnace is in regular operation.

Creating a Model
Since the furnace consists of many identical functional units, the model of one cell is representative for the entire baking process.

The maximum baking temperature at the product and the uniformity of the temperature distribution in the pits are two decisive factors for the quality of the products. Considering that the heat transfer in the section directly depends on the volume of the flue gases flowing through the pit walls, a uniformly distributed flow in the section is the precondition for the even heat-up.

Measuring Process
In order to show the actual flow pattern in a section, a plexiglass model, scale 1:10, was built.

Calculations
The calculations were made on the basis of the finite element method. Since the exactness of the results depends on the quality and density of the mesh, a manual adjustment of the automatically generated data array is conducted.

To establish a flow pattern in the section, several measurements, which are minutely controlled, are taken. Despite the fact that the basic principle of operation has not changed, Riedhammer continuously advances and optimizes the design of this type of furnace.

Figure 7, were obtained using a multichannel digital anemometer.

Compilation of the achieved results of the measurements was accomplished by transferring the complete data pattern into a data file. A computer model system was then used to analyze and evaluate the resulting data and extend it to the many other geometrical variants of the equipment.

The spatial distribution of the flows under the section cover, displayed by vector graphics, is best shown on the x-y level, Figure 9. One can see the distribution of the individual fluid flows in the direction towards the openings of the saggar bricks. The largest volume flows may be observed in those openings opposite the fire shafts. Figure 10 shows an enlarged section, whereby the directional distribution of the flow is clearly illustrated. On the other hand, the directional flow distribution in the fire shafts is very even.

The differences in the flow distribution can be explained with the laminar effect of the surface of the inner sides of the cover and the various flow resistances of the individual pit openings.