Successful Vacuum Drying !

Merk Process

Innovation in Drying by Microwaves

Microwave vacuum dryer are built as statically or continuously working plants.

From 2010 to 2012 Merk Process realized an AiF-project in cooperation with Karlsruhe Institute for Technology (KIT), Institute for Bio- and Food Technology, Division I: Food Process Technology (LVT):

„Development of a gentle Method of constant and efficient Puffing of Food with little Residual Moisture using a special developed, energy saving Vacuum Microwave Free Fall Dryer VMFD.“

Figures 1+2: Practical implementation of the plant in pilot scale

Corn semolina samples especially developed and produced by KIT using an extruder were puffed and dried very successfully as a prototype product.
The designed pilot plant VMFD also is based on the „HEPHAISTOS“ microwave technology developed by KIT Campus Nord.
In this process microwave energy is introduced into a hexagonal process chamber using slot conductors. The microwaves impinging on a so-called widened edge will be refracted according to the laws of geometrical optics and spread uniformly in the room. This effect is reproduced by every further impinging on an edge. Thus leads to nearly 100% homogeneous field distribution on a circular cross-sectional area inside this hexagon.

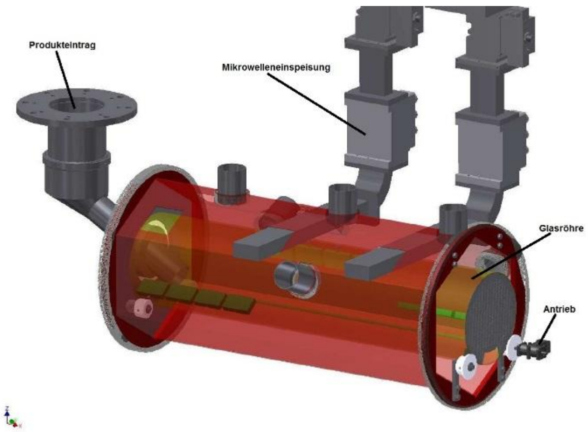

Figure 3: Plant design, hexagonal cross section of process chamber with glass tube for product transport insided

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Especially when drying has progressed and therefore the dielectric properties for energy absorption of the product are declining impressing a homogeneous field is of enormous importance because constant heating assures a constant drying process and avoids partly burning of already dry product.

For conveying the product through the process chamber a turnable drum, alternatively made from glass or PTFE, was installed inside. Mixing resp. distribution of the product inside this drum will be limited to a circular cross section in the lower third of the drum depending on the mode of operation. To estimate the electromagnetic field distribution in advance it was simulated in this pilot plant with Teflon tube and product (to simplify matters not single pellets are used but the product in cylinder-shape) inside. The dielectrical properties of the standard product needed for this simulation were measured by a network analyzer with connected cavity resonator as a function of moisture content.

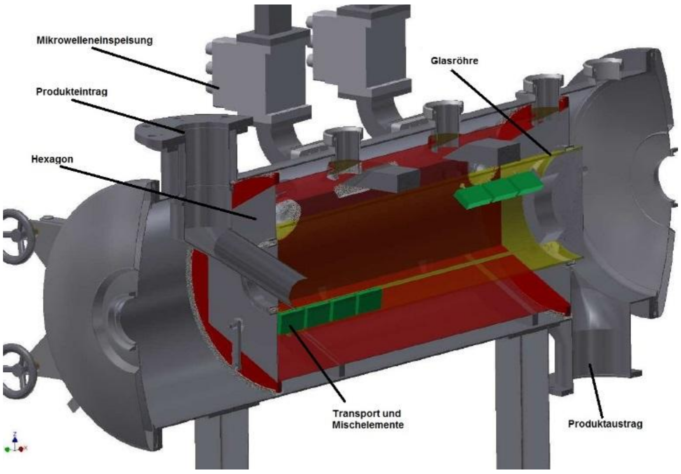

Figure 4: Cross section through the plant

The dielectrical properties diminish with decreasing moisture content. The storing factor ε‘ ranges from 5,0 to 2,25 in a scope of moisture content of 38 % to12 %. The dielectric loss factor ε‘‘ ranges between 1,0 and 0,1. Because both factors are declining linearly with moisture content the loss angle tan(Δ) is nearly constant over the whole range of moisture content. Thereby the microwave power consumption should be hardly changing when drying progresses. Therefore it was sufficient to simulate the field distribution in product only using the moisture content (20 %). The simulation shows constant energy absorption of the product. This should lead to a homogeneous heating and drying. Also a constant field distribution arises in simulation inside the Teflon tube and in the whole process chamber, saving the inner components from burning and wear.

Therefore design of the plant follows criteria of homogeneous electromagnetic field distribution resp. homogeneous heating of the product. Energy efficiency of the plant was investigated during practical trial execution.

To characterize the samples the expansion index and the moisture content of the pellets were determined plus visual examination of the product. The expansion index was 1,80. This corresponds to an increase of the original volume of 80 %. The final moisture content was under 8 % for all pellets. This value corresponds to an a_w value lower 0,45 and thus offers sufficient storage stability of the product at room temperature. This even means an improvement of the results compared to data worked out in pilot scale. Figures 5 and 6 are showing the generated end products.

Figures 5+6:End products

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Visual examination of the end products shows that all pellets have expanded very homogeneously.
This argues for constant microwave power consumption of the whole product charge during process. Further no burned or still moist pellets are found at the end of the process. Finished products in the collecting vessel don't show damages and also they were not interspersed with fine particles. This argues for gentle handling and mixing of products in the process chamber. The produced product samples are demonstrating the efficiency of a VMFD in pilot scale.

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