



MEAM VP

Microwave Vacuum Drying

APPLICATION NOTE

Microwave heating is a dielectric heating. The microwave energy converts into heat energy due to the polar structure of the molecules, atoms and ions. This heating is suitable for poor electrical conductors while induction heating suits for good electrical conductors. The supply of energy effects occurs without intermediary heating elements and therefore the process has no inertia.

The production of heat happens in the material itself and therefore without thermal dissipation: only the product heats, not its environment. The heating is direct and fast and not bounded at all by the temperature level of the process if the loss factor of the product is temperature independent. The dissipation of the heat occurs in the product and is therefore homogeneous. The absorption of the energy takes place progressively with the penetration of the radiation into the mass of the product. This characteristic of microwave heating is responsible for the good quality of the product and for the good working conditions of the operation. These advantages lead to a final product with an excellent quality. Main microwave functionalities provided to the industry are heating, drying, conditioning, thawing, tempering; gluing, sterilizing, blanching, and sintering amongst others.

Advantages of microwave technology:

- Fast process, resulting in increased throughput and production
- Uniform/homogeneous heating
- More energy efficient as compared to classical systems
- Lower operation and maintenance costs
- Environmentally friendly due to electrical energy

By applying a vacuum, several additional advantages are obtained. On the one hand, as a result of the lack of oxygen, drying processes can be carried out without the risk of oxidation reactions. On the other hand, the actual drying occurs at very low temperatures, between 5 °C and 30 °C. This leads to an increase in drying efficiency in most cases as well as the preserving of valuable components inside the products (e.g. vitamins), the avoidance of temperature shocks, and the evaporation of non-volatile components.

To combine microwave energy with a vacuum, a new set-up has been constructed, i.e. the MEAM VP (Figure 1) with adjustable power. The microwave system has a multi-mode cavity and is air-cooled. The microwave part consists of a launcher, an insulator, a possibility to measure power and reflection, and a connection to the vacuum chamber. This chamber has a volume of 72 litres and its dimensions are 30 cm × 40 cm × 60 cm. The vacuum chamber is connected to a 0.48 kW vacuum pump.

In Figure 1, an estimate of the gain by the addition of microwave energy is made. From the data, it can be derived that the evaporation of moisture is linear with time when microwave energy is put into the system (dark green curve) in contrast to a downward bend and hence, slower evaporation rate when this external energy source is absent (light green curve). In total, a 75% gain can be obtained with these parameters when the evaporation is executed for one full hour.

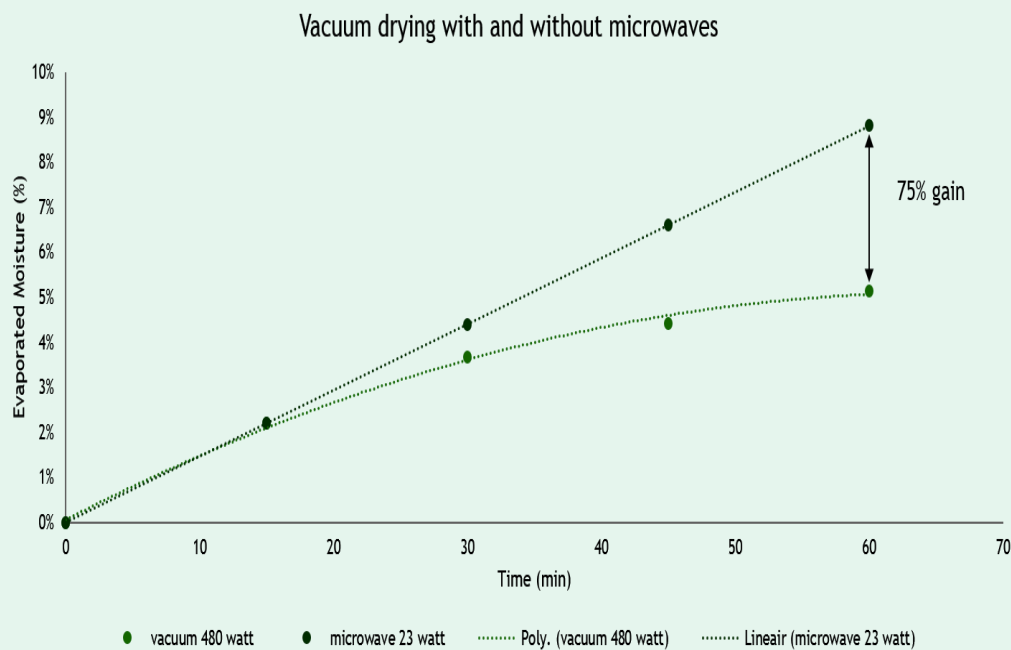


Figure 1. Vacuum drying with and without microwaves

Conclusions:

- Evaporation of water molecules occurs at very low temperatures, i.e. 17 °C at 6 mbar
- Temperature shocks are avoided, resulting in better preservation of the product
- Using microwave energy, a 75% gain of the water evaporation rate can be achieved