MICROWAVE HEATING

Electromagnetic radiation is classified by wavelength or frequency. The electromagnetic spectrum between frequencies of 300 MHz and 300 GHz is represented by microwaves. Since microwaves are used in radar, navigational equipment, and communication equipment, their use is regulated by governmental agencies.

Microwaves have certain similarities to visible light. Microwaves can be focused into beams. They can transmit through hollow tubes. Depending on the dielectric properties of a material, they may be reflected or absorbed by the material. Microwaves may also transmit through materials without any absorption. Packaging materials such as glass, ceramics, and most thermoplastic materials allow microwaves to pass through with little or no absorption. When traveling from one material to another, microwaves may change direction, similar to the bending of light rays when they pass from air to water.

In contrast to conventional heating systems, microwaves penetrate a food, and heating extends within the entire food material. The rate of heating is therefore more rapid. Note that microwaves generate heat due to their interactions with the food materials. The microwave radiation itself is nonionizing radiation, distinctly different from ionizing radiation such as X-rays and gamma rays. When foods are exposed to microwave radiation, no known non thermal effects are produced in food material (IFT, 1989 ; Mertens and Knorr, 1992).

The absorption of microwaves by a dielectric material results in the microwaves giving up their energy to the material, with a consequential rise in temperature.

Microwave Heating of Foods

Heating of foods in a microwave field offers several advantages over more conventional methods of heating. The following are some of the important features of microwave heating that merit consideration.

Speed of Heating

The speed of heating of a dielectric material is directly proportional to the power output of the microwave system. In industrial units, the typical power output may range from 5 to 100 kW. Although high speed of heating is attainable in the microwave field, many food applications require good control of the rate at which the foods are heated. Very high-speed heating may not allow desirable physical and biochemical reactions to occur. The speed of heating in a microwave is governed by controlling the power output. The power required for heating is also proportional to the mass of the product.

Frozen Foods

The heating behavior of frozen foods is markedly influenced by the different dielectric properties of ice and water.Due to its low dielectric loss factor, ice is more transparent to microwaves than water. Thus, ice does not heat as well as water. Therefore, when using microwaves to temper frozen foods, care is taken to keep the temperature of the frozen food just below the freezing point. If the ice melts runaway heating may occur because the water will heat much faster due to the high dielectric loss factor of water.

Shape and Density of the Material

The shape of the food material is important in obtaining uniformity of heating. Nonuniform shapes result in local heating; similarly, sharp edges and corners cause nonuniform heating.

Food Composition

The composition of the food material affects how it heats in the microwave field. The moisture content of food directly affects the amount of microwave absorption. A compositional factor that has a marked influence on heating rates in microwaves is the presence of salt. As stated previously, an increased concentration of ions promotes heating in microwaves. Thus, increasing the salt level in foods increases the rate of heating.