B.9. MICROWAVE PENETRATION DEPTH MODELING IN THE DEHYDRATION OF CAPILLARY-POROUS MEDIA

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Abstract. Drying is a widely utilized technique for food preservation, typically involving the transfer of thermal energy to the product's surface via convection, conduction, or radiation. Among these methods, microwave drying has emerged as a particularly effective alternative. The physics behind microwave drying is sophisticated, as energy absorption occurs through two primary mechanisms: ionic conductivity and dipole relaxation. For high-moisture substances, dipole relaxation is the dominant process. When a dielectric material is subjected to an electric field, its ions, atoms, and molecules become excited; the resulting motion and subsequent collisions convert kinetic energy into thermal energy. Developing a mathematical model for the microwave heating of capillary-porous bodies allows for new analytical solutions. These solutions make it possible to precisely determine how various parameters—such as electric field strength, processing duration, and wave penetration depth—impact drying intensity. Penetration depth is a decisive factor in ensuring heating uniformity and efficiency. Our modeling and calculations for a product with 40% moisture content situated this parameter between 2 and 6 cm. The numerical solution derived for penetration depth is a critical factor in the dehydration of capillary-porous materials. Furthermore, it provides a necessary benchmark for evaluating the accuracy and reliability of other theoretical models.
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