

# Special Issue on “Microwave Applications in Chemical Engineering”

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Editorial

# Special Issue on “Microwave Applications in Chemical Engineering”

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**Abstract:** Microwave heating has been widely used in the chemical industry because of its advantages, such as fast heating rate, selective and controllable heating, increasing reaction rate and reducing by-products in chemical reactions. The Special Issue contains research on microwave applications in chemical engineering.

## 1. Microwave Equipment and Method Optimization

Microwave-assisted chemical production needs a device that generates microwave energy. The common microwave sources are magnetron and solid-state power generators. Magnetron has the advantages of low cost and high output power, while the solid-state power generator has the characteristics of output power variability and frequency adjustability. In the paper by Mitani et al. [1], a microwave irradiation probe of cylindrical metal applicators for solid microwave heating is designed and studied by using the 3D finite element simulation method. Compared with the traditional system, the designed system helps to reduce the size of the applicator and overall equipment.

Although microwave-assisted processing is widely used, there are still some shortcomings and limitations. When a large number of solid materials are stacked in the microwave applicator, the existence of some sharp edges, tips or submicroscopic irregularities may lead to electric sparks or arcs. In the paper by Wang et al. [2], a method of adding fluid materials with different dielectric constants to solid stacking materials is proposed. The silicon carbide spheres are stacked on the bottom of the quartz cup, and the microwave heating process of water and glycerin as fluid materials is compared by the finite element method. The effects of different permittivity of fluid materials on the heating uniformity were analyzed.

When microwaves act on different materials, sometimes it is necessary to optimize the heating mode according to its characteristics, such as when oleic acid is used in biodiesel production, it needs to be heated before esterification. However, oleic acid is a kind of solution with low dielectric loss and weak absorption capacity for microwave energy, so it is difficult to be directly heated by microwaves. In the paper by Ma et al. [3], a microwave heating model for heating oleic acid was designed: in a quartz tube, oleic acid flows through the porous medium with high dielectric loss, and the porous medium is heated by microwave to indirectly heat the oleic acid. The effects of different flow rate of the oleic acid and porosity of the porous media on microwave heating efficiency were analyzed.

## 2. Application of Microwave Heating in Material Extraction

In addition to the differences between the materials used in the production of medicinal materials, food and daily necessities, the extraction process also has a significant impact on the product quality. In the extraction of essential oil from plant materials, the common methods are the conventional hydro-distillation method (HD) and the microwave-assisted hydro-distillation (MAHD). Research

shows that microwave-assisted extraction can improve the yield and quality of volatile oil. In the paper by Tran et al. [4], the MAHD method was used to extract essential oil from Vietnamese basil, and response surface methodology (RSM) was used to optimize the extraction process from raw material to water ratio, microwave power and extraction time. Based on the analysis of the chemical components of the essential oil extracted from Vietnamese basil, and compared with other studies, the application of Vietnamese basil in the possible large-scale production was proposed. In addition, Bachtler et al. [5] studied and evaluated the extraction kinetics of polyphenols extracted from red vine leaves by using fully automatic laboratory robots and unconventional processing technologies such as ultrasonic (US), microwave (MW) and pulsed electric field (PEF).

In recent years, the application of traditional Chinese medicine has been widely considered. The extraction of healthy compounds from traditional Chinese medicine is an important direction of the development of traditional Chinese medicine, so it is necessary to develop an efficient and simple extraction process. In the paper of He et al. [6], ultrasonic-assisted extraction (UAE) is used to extract antioxidant flavonoids (AFs) from *Aurantii fructus* (zhìqiao, ZQ). Response surface methodology (RSM) was used to optimize the ethanol concentration, extraction temperature, extraction time and other factors to improve the extraction process of antioxidant flavonoids in ZQ. The suitable extraction conditions of AFs in ZQ were studied. Then, the main components of AFs in ZQ were analyzed by liquid chromatography combined with quadrupole time-of-flight mass spectrometry (LC–Q–TOF–MS).

### 3. Application of Microwave Heating in Waste Treatment and Drying

The traditional treatment of carbon fiber-reinforced polymer (CFRP) waste is usually by landfill disposal or incineration. At present, a variety of technologies for carbon fiber recovery from carbon fiber reinforced epoxy composites have been proposed. In Deng's paper [7], the degradation of epoxy resin in the CFRP waste and the recycling of carbon fiber were studied by microwave thermolysis and traditional thermolysis respectively. The effects of reaction temperature and reaction time on the recovery of carbon fiber were studied, and the properties of carbon fiber were characterized to compare the characteristics of the two methods.

In view of the problem of the drying treatment of the drill cuttings generated in the drilling operation, in the paper by Tinmaz Köse [8], two drying systems, microwave drying and conveyor belt drying, were used to dry cuttings containing water-based drilling fluid. The differences of drying time and energy consumption between the two drying systems were compared. Zhao et al. [9] studied the thin-layer drying kinetics and mathematical model of Zhaotong lignite under different temperature (100–140 °C) and different microwave power (500–800 W). The effective diffusion coefficient and activation energy of lignite during the drying process were determined.

The above article covers the design and optimization of microwave equipment and some microwave applications in chemical engineering. These studies not only have practical significance, but also have some reference value for the optimization and expansion of microwave applications in the future.

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