Research on Microwave drying for the Sawdust with multiple waveguide

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1. Introduction

It is generally not economical to use microwaves to replace conventional drying methods for complete drying processes. However, Microwave heating provides a positive gradient for moisture to migrate towards the surface, thus significantly reducing drying time. This process also resulted in a 20 to 25% savings in energy [1]. Microwave drying has a major advantage in speeding up the final drying in the falling rate region in which conventional drying becomes effective and takes a long time due to reduced heat and moisture transfer [2].

This paper presents a numerical study of the temperature and the electric field strength in microwave drying model with multiple waveguide using COMSOL [3].

2. Model

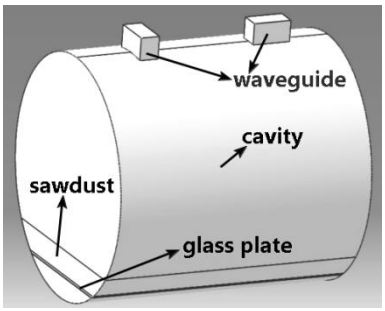
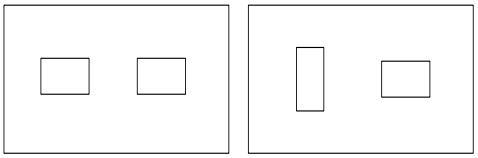


Fig. 1 Microwave drying system for simulation

The resonant cavity is cylinder, and its length is 593mm, and radius is 250mm. In the bottom of the resonant cavity have a glass plate. Its thickness is 5mm, and on plate we take thickness 50mm sawdust. The Microwave drying system for simulation is shown in Fig. 1.

The dimension of waveguide have wide wall a=43.18mm and narrow wall b=86.36mm, waveguide configurations are shown in Fig. 2(The case 1 is parallel type, The case 2 is perpendicular type).



case 1(parallel type) case2(perpendicular type)

Fig. 2 The configurations of waveguide

3. Materials

The sawdust material properties are usually different according to environment. In the 2.45GHz, 20℃, which is our test environment, sawdust material properties are shown in table 1[4].

Table 1 Sawdust material properties

Density(kg/m^3)	200
Relative Permittivity	1.6-0.21j
Thermal conductivity(W/m • K)	0.08
Heat capacity(J/kg • K)	1.4×10^3
moisture content	20%

In simulation we use steel AISI 4340 for Metal Boundaries, and used glass for belt.

4. Simulation results

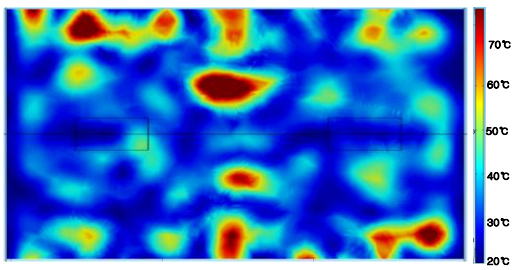
The conversion of the microwave energy to electromagnetic power of heat generation can be approximated as:

$$P = 2\pi f \varepsilon_0 \varepsilon_r'' E^2 \quad (1)$$

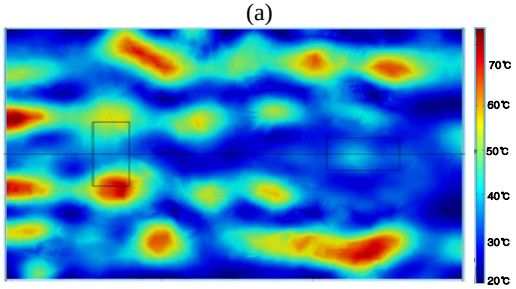
where P is the power deposition density into the material (W/m^3), E is the electric field strength (V/m), f is the operating frequency (Hz), ε_r'' is the relative dielectric loss factor.

If the electric field strength is uniform, the temperature is also uniform.

Fig. 4 shows the temperature distribution of parallel type (a), perpendicular type (b) (z=25mm is in middle of the sawdust, heating time 30s). Fig. 4(a) temperature range is 20~115.9℃, and Fig. 5(b) temperature range is 20~77.35℃. So in microwave heating sawdust, perpendicular type is more uniform than parallel type.



(a)



(b)

Fig. 4 Temperature distribution

In conventional method heating is from surface to inside, but in microwave heating system, it is not just heating surface, inside is also heated.

Fig. 5 and Fig. 6 are the temperature distribution of the top surface and bottom surface of the sawdust. Considering Fig. 4(b), Fig. 5 and Fig. 6, we can know microwave heating is not just heated the surface of sawdust.

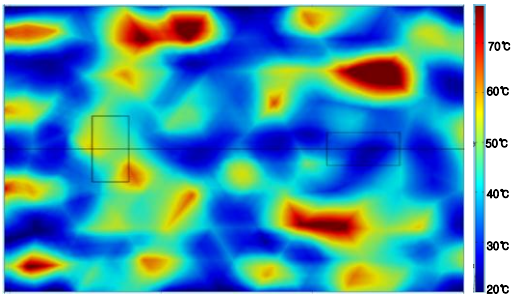


Fig. 5 Tmperature distribution of top surface

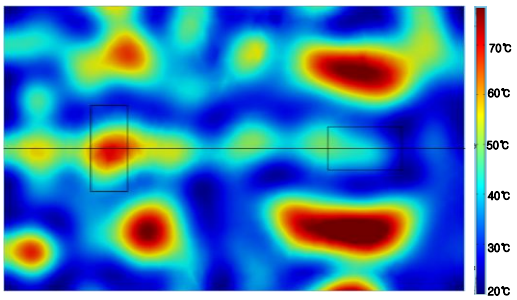


Fig. 6 Temperature distribution of bottom surface

5. Conclusions

In order to improve drying effect, we can adjustment the configuration of the waveguide. Through the simulation by using COMSOL we found microwave drying effect of perpendicular type is better than parallel type in the point.

References

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