Analysis of Temperature Distribution in Coal-containing Chromite Fines During Microwave Heating

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Abstract: Temperature distribution of coal-containing chromite fines in cyclindrical crucible is analyzed by experimental and numerical methods during microwave heating. The temperature distribution changed with the Lambert's law and density of power of coal-containing chromite fines. For cylinder-shaped fines, the high temperature region exists different at different time. The addition of moisture content has a serious effect on the temperature distribution. The calculated temperatures are in good agreement with the experiment values.

Key words: coal-containing chromite fines; microwave heating; finite element; temperature distribution
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1 Introduction

In recent years, people have been attempting to apply microwave technology in metallurgy by the characteristic of volume calefaction[1], but the research in this filed is only at early stage[2].

Success in the numerical simulation of electromagnetic propagation has recently generated interest in numerical modeling of heat transfer induced by microwave radiation. Among many available numerical techniques, the finite element method has been extensively used to solve heat transfer problems. FEM have the ablility to handle complex geometries, boundary conditions, spatial and temporal properties variations. Based on generic of FEM-based computer codes, it can also be applied to solve a wide range of problems[3—5].

2 Results and discussion

The predictions of temperature distribution of conventional heating which output power is 10 kW are shown in Fig. 1. The predictions of temperature distribution for microwave heating coal-containing chromite fines are shown in Fig. 2 which corresponds to the initial temperature of 20 ℃ and microwave power level of 10 kW. Here, microwaves are transmitted along almost all direction towards the crucible which is used to put in sample.

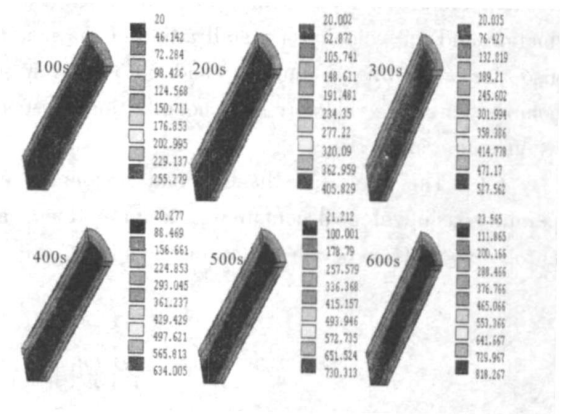

Fig. 1 Conventional temperature distribution at various heating times

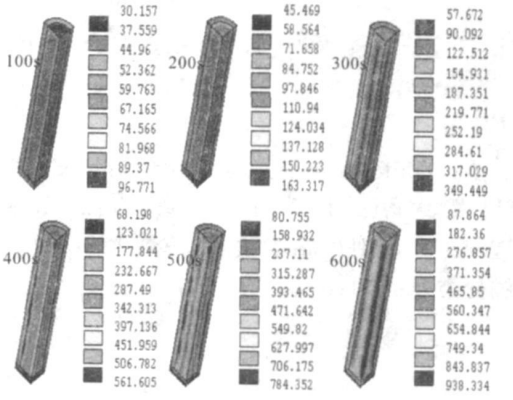

Fig. 2 Microwave temperature distribution at various heating times

Most importantly, the effects of the way of heating

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on temperature distribution are discussed by considering the two heating ways: microwave heating and conventional heating at same conditions by simulation (see Fig. 1, Fig. 2). In contrast to that case of microwave heating, which results in voluminal heating by microwave inspired by magnetron around. In Fig. 3, the distribution of conventional heating that operates at a same power has more different than that of microwave heating. It is found that gradient of temperature is clear from the outer to inside part. The highest temperature appear in the process of microwave heating. It is well validated the voluminal heating characteristic of microwave.

3　Conclusion

The numerical analysis presented in the paper describes the advantage of microwave heating compared to conventional heating and the characteristic of coal-containing chromite fines in microwave field. The following papagraph summarizes the conclusions of this study.

(1) A compared model between microwave heating and conventional heating is proposed. It is successfully used to describe the characteristic of microwave heating.

(2) A mathematical model for microwave heating of coal-containing chromite fines is constructed. It is helpful to understanding the heating characteristic of coal-containing chromite fines.

(3) The influence of irradiation times, working frequencies and sample size and evaporation in the sample is clarified. The simulated results for the temperature point within the sample are in agreement with the measure results.

References:

[1] Carbothermic reduction by microwave heating[C] // ISIJ International. Marcelo Breda Mourao, Ivan Parreiras de CARVALHO JR AND CYRO TAKANO, 2001, 41: 27—30.

[2] QU S L. Microwave application an modeling in direct reduction of iron oxide[D]. USA: Michigan Technological University, 2004.

[3] LIN Y E, Anantheswaran R C, Puri V M. Finite element analysis of microwave heating of solid foods[J]. Journal Food Engineering, 1995, 25: 85—112.

[4] MARCOS E C OLIVERA, ADRIANA S FRANCA. Finite element analysis of microwave heating of solid products[J]. International Communications in Heat and Mass Transfer, 2000, 27 (4): 527—536.

[5] MINARY E J, BOCCACCINI A R, VERONESI P, et al. Processing of novel glass matrix composites by microwave heating[J]. Journal of Materials Processing Technology, 2004, 155—156: 1749—1755.

微波加热过程中含煤铬铁矿粉温度分布的分析

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摘　要：引用实验和数值的方法对柱状坩埚内含煤铬铁矿粉在微波加热场中的温度分布作了分析。对于柱状物料，不同时间内的温度的高温区域的分布是不同的，物料中水份的含量对于温度分布有着很大的影响。利用模型计算所得的温度值与实验值有很好的吻合。

关键词：含煤铬铁矿粉；微波加热；有限元；温度分布

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