The effect of microwave treatment upon an iron Ore comminution

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ABSTRACT

The influence of microwave pre-treatment on mineral ore breakage has been investigated. Samples of iron ore were microwave treated prior to breakage testing and change in breakage determined. Drop weight tests were used to quantify the change in strength in terms of reduction in required comminution energy. The drop weight test parameters of untreated iron ore was compared to microwave-treated iron ore under the same experimental conditions and it was found that microwave-treated materials is softer than untreated in terms of the impact breakage parameter values and the abrasion breakage parameter values. After microwave treatment, about 100% increases in abrasion breakage parameter was achieved while maximum increasing in impact breakage parameter was 36%. It seems that microwave treatment is more effective for abrasion breakage mechanism; because abrasion is, a surface phenomenon and microwave treatment is more effective at surface heating.

Keywords: Microwave Processing; Iron ores; Grinding

INTRODUCTION

Microwaves are a form of electromagnetic energy with associated electric and magnetic fields. Microwave frequencies are in the range of 300 MHz to 300 GHz and the microwave wavelength is from 1 to 300 mm. 2450 MHz is the most commonly utilized frequency for the home microwave oven, which was invented by Percy L. Spencer (1949).

In recent years, a growing interest in microwave heating in minerals treatment has emerged and a number of potential applications of microwave processing have been investigated. These included microwave assisted ore grinding, microwave assisted carbothermic reduction of metal oxides, microwave-assisted drying and anhydration, microwave-assisted mineral leaching, microwave-assisted roasting and smelting of sulfide concentrate, microwave-assisted pretreatment of refractory gold concentrate, microwave-assisted spent carbon regeneration and microwave-assisted waste management (Kingman et al., 2000).

One of the most important possible applications of microwave heating is assisting ore grinding. Walkiewiez et al. (1988). showed that thermal stress fracturing along grain boundaries was induced in some samples after microwave heating, and suggested that this could significantly influence not only the grindability of microwave- treated ores, but also mineral libration as well. Walkiewiez et al. (1991) later investigated the former claim with tests on grindablity of several microwave -treated ores, and showed reductions in work index from 1.3% to 23.7%.

Works on grindability of coal by Marland et al. (2000) indicated that reduction in work index up to 50% was occurred after microwave treatment. The largest strength reduction was obtained from lower ranked coals.

Kingman et al. (2000) carried out a qualitative study of the influence of mineralogy on the response of ores to microwave treatment. It was concluded that samples with a mixture of good heaters and medium heaters in a lattice of poor heaters with a coarse grain size gave the greatest reduction in work index after microwave treatment.

Vorster et al. (2001) performed several tests on a massive copper ore and a massive copper-zinc ore, both from Neves Corvo in southern Portugal, using a 2.6 kw multimode cavity operating at 2.45 GHz. Quenching after 90 seconds of microwave exposure led to a 70% reduction in work index of the massive copper ore. The effect of quenching was also illustrated with test on the massive copper-zinc ore, where after 90 second of microwave exposure with no quenching, a reduction of 50% in the strength of the ore was obtained. While the addition of quenching directly after microwave treatment led to a further 15% reduction in work index.

Kingman et al. (2004) carried out an investigation into the influence of microwave treatment on a lead-zinc ore comminution. Drop weight tests were used to quantify the change in strength in terms of reduction in required