THE EFFECT OF GRINDING TIME ON THE SPECIFIC SURFACE AREA DURING INTENSIVE GRINDING OF MINERAL POWDERS

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Abstract: *Based on experimental observations, a model has been developed to describe the effect of grinding time on the changes of BET surface area of a mineral substance during intensive grinding process. Validity of the proposed model was tested by the experiments performed using a natural chalcopyrite mineral as well as the published data. It was shown that the model can predict the experimental results with a very good accuracy and can be used to predict what may happen under the similar experimental conditions.*

Keywords: *Modeling, Minerals, Chalcopyrite, Ball milling, Specific surface area*

1. INTRODUCTION

Mechanochemical pretreatment of minerals by intensive grinding can improve the efficiency of subsequent processes such as leaching, reduction, materials synthesis, etc. this is due to the formation of new and additional surface area as well as creation of lattice defects [1-7]. Moreover mechanochemical pretreatment lowers the reaction temperatures and enhances the reaction kinetics. As a consequence, the subsequent processing can be performed in simpler and less expensive reactors with shorter reaction times [1,8,9].

Different types of milling apparatus such as planetary mills, vibratory mills, stirring ball mills, pin mills and rolling mills [10] may be used for grinding operations. It is believed that wet grinding and/or the use of small milling balls (e.g. stirring ball mills) is favorable for the generation of new and additional surfaces, while, dry grinding and/or the use of larger milling balls (e.g. vibratory and/or planetary mills) brings about intensive bulk disorder in the milled material [11]. High energy grinding is accompanied by an increase in the number of material particles as well as generation of fresh surfaces which were unexposed prior to grinding operation [10]. Nevertheless, formation of new surfaces is restricted to a limit beyond which aggregation of particles takes place with the consequence of the formation of agglomerates [12]. It has been reported that in some cases, specific surface area increases first with increasing grinding time but reaches to a constant value after a certain grinding time [13]. For such circumstances, Tanaka and Chodacov [14] have proposed the following equation to describe the process of new surface formation:

$$S=S_{max}(1-e^{-k_1 t}) \qquad (1)$$

where, S is the specific surface area at a given time t and S_{max} is the maximum attainable specific surface area. The constant k_1 implies the significance of rate constant of the new surface formation.

In some other cases, the increase in specific surface area due to mechanical activation reaches to a maximum upper limit after the elapse of a certain time, and then decreases to a constant value. For such cases, relationship between the grinding time t and the specific surface area S, has been formulated by Mockovciakova and Balaz [14] according to the following equation:

$$S=A+(B+k_2 t)e^{-\alpha t} \qquad (2)$$

In this equation, A is the value of specific surface area corresponding to mechano-chemical equilibrium, i.e., the point at which the rate of