Investigation of the asymptotic behaviour of a closed-circuit grinding system

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A discrete mathematical model for a grinding mill-classifier system expressed in the form of delay difference equations was developed. In the model, the mixing of the material to be ground by the axial dispersion model, the breakage kinetics by the first order breakage law, and the classifier by a usual classification function are described.

Closed-circuit grinding system, characterised by external classifier can be used successfully to reduce the energy consumption, and at the same time, to prevent the 'over-grinding' of the product. However, because of the continuous recycling of the coarse material, such a system may exhibit instabilities in the form of oscillations and overloading of the mill, therefore a more detailed analysis of the system behaviour is required.

The closed-circuit grinding system considered in this paper is as follows: the fresh material to be ground enters the mixer and it mixed perfectly with the still coarse material recycled from the classifier. Travelling through the mill, the particles are continuously ground and mixed because of their stochastic motion. The ground material is sent to the classifier, from that the fine component is removed as the finished product, while the coarse material is recycled.

The discrete model developed is the basis of the computer simulation. The whole grinding process can be observed, statistical characteristics of the ground material can be calculated at any moment of time with the aid of simulation. The influence of the parameters of both the mill and the material to be ground can be investigated via simulation.

At this time, we focus on the asymptotic behaviour of the model. For that reason the set of model equations is written in matrix form. The asymptotic behaviour of the grinding mill-classifier system was investigated by means of the eigenvalues of matrices, and the influence of the classification was examined via numerical experiments.