A new prediction method for the viscosity of the molten coal slag

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Abstract: Viscosity is the key factor affecting the flowability of molten coal slag in the entrained flow gasifier. The volume fraction and morphology of solid phase in slag are important factors affecting the slag viscosity. In this study, the malt syrup and the particles with different sizes and morphologies were chosen as the simulation medium to study the effect of particle morphology on the suspension viscosity. The influences of size, shape and aspect ratio of solid particles on the suspension viscosity were considered. It was concluded that the suspension viscosity increased with the decrease of the particle size. The suspension viscosity increased with the increase of the aspect ratio of the particles. This phenomenon was more obvious under the high volume fraction of solid phase. With the same size and aspect ratio, the non-spherical particles had greater effect on the suspension viscosity than spherical particles. A correction factor (β) was used to modify the viscosity model with the consideration of particle size, shape and aspect ratio. The model of the suspension viscosity obtained by the previous work was used to predict the viscosity of crystalline slag. Equations are as follows:

$$\eta = \eta_0 \left(1 - \beta\varphi\right)^{-2.5}, \tag{1}$$

and

$$\beta = 0.9672 C e^{-0.0022d} e^{0.0126(\theta-1)}, \tag{2}$$

where φ was the solid phase volume fraction in the molten slag, η_0 was Newtonian viscosity of the suspending liquid, β was the correction factor, d was the particle size, and θ was the particle aspect ratio. C was a constant related to the particle shape. Ten kinds of crystalline slags were applied in this study to prove the accuracy of the modified viscosity model. The viscosity of molten slag predicted by the model (CSM) agreed with experiment data.