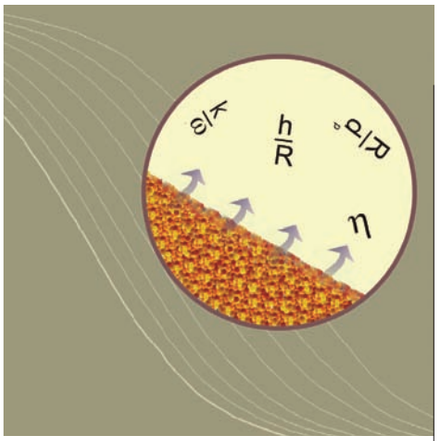
SLOWLY UNFURLING THE MYSTERY OF ROTARY KILNS



→ *A cross-section of a rotary kiln shows the particles rolling down the surface of the bed, enhancing evaporation or gas-solid reaction as the kiln turns clockwise. The rate (designated as efficiency, μ) depends only on k/w (ratio of reaction rate to rotation speed) and h/∑ (bed fill) for low rates and an additional third parameter R/d_p (kiln radius/particles diameter) for fast processes.*

For the hundred years and more that rotary kilns have been used industrially, effective modelling of the gas-solid interactions has evaded researchers.

But Professor Mike Heydenrych of the Department of Chemical Engineering at the University of Pretoria has solved the mystery. He has identified the important dimensionless groups that describe the performance of rotary kilns. Rotary kilns are involved in many aspects of solids processing, whether in drying, incineration, mixing, heating, cooling, humidification, calcination, reducing, sintering and gas-solid reactions.

Heydenrych has developed models to predict their behaviour in a number of different conditions. His work shows that for reaction or drying operations that occur at slow rates, typically longer than two hours, it becomes necessary to model the so-called "passive layer" of the bed of a rotary kiln. There is no inter-particle movement in the passive layer. He has shown that for such slow processes, the rate depends on just two parameters: the ratio of the reaction rate constant to the speed of rotation and the amount of bed fill.

For faster processes the upper surface of the rotary kiln (the active layer) becomes important for modelling the rate of reaction or drying. This rate depends on the same parameters as the slower rates and the ratio of the particle diameter to the diameter of the rotary kiln. This helps to unravel the mystery surrounding the processes within rotary kilns. The models that have now been developed are simple to implement, and provide insight for better design of rotary kilns. This is particularly important for South Africa, where rotary kilns are used extensively, especially in the minerals processing and cement industries.

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