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Xiao Dong Chen[1,2] and Aditya Putranto[2,3]

[1]*School of Chemical and Environmental Engineering, College of Chemistry, Chemical Engineering and Material Science, Soochow University, Suzhou, Jiangsu Province, P.R. China*
[2]*Department of Chemical Engineering, Monash University, Clayton, Victoria, Australia*
[3]*Department of Chemical Engineering, Parahyangan Catholic University, Bandung, Indonesia*

Among the drying models available in the literature, the REA model (which was first proposed in 1996) is semi-empirical. It was described based upon a basic physical chemistry principle. The "extraction of water from moist material" is signified by applying the activation energy concept. The single expression of the extraction rate represents the competition between evaporation and condensation. It also encompasses the internal specific surface area and mass transfer coefficient, and thus is linked to material characteristics. The REA can be classified into two categories—Lumped (L) REA and Spatial (S) REA—which can be used to deal with drying a material as a whole or considering the local phenomena within the material, respectively. Both models have been proven to be very effective. The REA is effective for generating parameters since only one accurate drying run is required to establish the relative activation energy function. Both internal and external resistances are modeled by the REA. In its lumped format, the REA is employed to describe the global drying rate, while in the S-REA, the REA is used to model the local evaporation rate. This article covers fundamentals of the REA which have not been fully explained, as well as the most recent development and applications. The application of the S-REA as a non-equilibrium multiphase model is highlighted.

FUNDAMENTALS OF THE REACTION ENGINEERING APPROACH (REA)

To begin the discussion of the REA concepts, we may need to outline the physical chemistry principles of chemical reaction with little originality on our part to form the basis of the REA idea. The most prominent idea of reaction engineering is the expression of the chemical reaction rate. A chemical reaction rate of species *A*, involved in the reaction of two species (*A* and *B*) to yield a product, is commonly expressed as:

$$-\frac{dc_A}{dt} = k_A c_A^{nA} c_B^{nB} \qquad (1)$$

where n_A and n_B are the orders of reactions associated with species *A* and *B*, respectively; k_A is a rate constant; and C_A and C_B are the concentrations of species *A* and *B*, respectively. This rate constant increases with temperature *T*, approximately increasing by 2–4 times with a temperature increment of 10 K. The relationship between a reaction rate constant, *k*, and temperature, *T*, has been generically described using the famous Arrhenius equation[1]:

$$-\frac{d\ln k_A}{dT} = \frac{E_A}{RT^2} \qquad (2)$$

where E_A is the activation energy of the reaction (J.mol^{-1}). This means that the value of $\ln k_A$ changes against temperature is proportional with the value of E_A. If the activation energy E_A is larger, the reaction rate is more sensitive towards temperature change. E_A can be variable against temperature when multiple reactions are occurring simultaneously.

When the range of temperature is not large, E_A may be considered as a constant. In this case, which is more commonly adopted in real life, the rate constant is expressed as:

$$k_A = k_{Ao} e^{-EA/RT} \qquad (3)$$

where k_{Ao} is a constant.

Evaporation-condensation is one of the fundamental processes in many fields of science and engineering. For decades, various experiments have been done to measure the absolute values of the evaporation or condensation rate, but there still remain many problems due to the lack of knowledge of the underlying molecular mechanisms.

Correspondence: Xiao Dong Chen, School of Chemical and Environmental Engineering, College of Chemistry, Chemical Engineering and Material Science, Soochow University, 178 Ganjiang E Rd., Ping Jiang Qu, Suzhou, Jiangsu Province, P.R. China; E-mail: xdchen@suda.edu.cn

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