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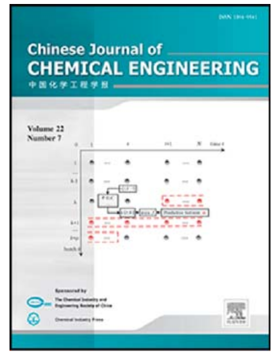

Correlation of the mean activity coefficient of aqueous electrolyte solutions using an equation of state

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Accurate estimation of mixing time in a direct contact boiling heat transfer process using statistical methods

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Abstract

A novel method relying on image analysis and statistics is developed to estimate the mixing time accurately in a direct-contact heat exchanger. The critical point determination of pseudo homogeneous process impact on the accurate estimation of mixing time is investigated by proposed three sigma (3σ) method, which satisfies approximately normal distribution and exceeding the range of μ-3σ occurring twice. Quantitative comparisons of the mixing time are conducted with mean value method, slope method and standard deviation method. Results show that correlation degree and correlation coefficient for the mixing time estimated by 3σ method give good agreement with the volumetric heat transfer coefficient average. Additionally, quasi steady state is quantified by time intervals between in-homogeneous time and mixing time. Experiments and simulations confirmed that neglecting critical point could result in significant errors in mixing time estimation. This method is capable of estimating the mixing time obtained by different mixing curves (e.g slope p) that vary at the beginning of mixing and rapidly become stabilized after fluctuations, which can be an alternative tool for practical engineering applications with good accuracy.

Keywords: direct contact heat transfer; mixing; Betti number; three sigma; simulation.

1 Introduction

Mixing plays a fundamental role in many industrial applications, but due to its complexity theoretical approaches are very limited. Monitoring or measuring the mixing properly is of great importance from the practical point of view and for the validation of theoretical models as well[1]. The presence of a second phase makes the flow and mixing process of the continuous phase even complicated, especially for a direct contact boiling heat transfer process. However, to obtain high quality products and high efficiency processes, mixing must satisfy not only the needs of mass and heat transport but also the required homogeneity in the vessel in the shortest time. It is thus believed that the information related to macro-mixing is very important to control the performance of reactions occurring in the continuous phase in the presence of immiscible oil drops[2]. The macro-mixing is usually characterized by mixing time, i. e. , the time required to achieve certain degree of homogeneity of an inert tracer or object. Mixing time is an important performance indicator for liquid-liquid stirred system. The mixing time in the presence of immiscible oil drops is sensitive to many variables such as agitation speed, impeller clearance, oil volume fraction and oil viscosity etc[3].

The accuracy requirements of the mixing time for different scales and processes are not the same.

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