This Week's Citation Classic

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Renon H & Prausnitz J M. Local composition in thermodynamic excess functions for liquid mixtures *AICHE Journal* **14**:135-44, 1968.

A new equation for the excess Gibbs energy of mixtures of nonelectrolytes is derived: the NRTL (Non-Random Two-Liquid) equation gives a good representation of vapor-liquid and liquid-liquid equilibria by adjusting its three parameters. It is extended to multicomponent mixtures without additional parameter. [The *SCI*® indicates that this paper has been cited 150 times since 1968.]

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"The NRTL equation (this name, recalling the molecular basis of the equation, was proposed in the cited paper and well accepted) was invented when I was a graduate student working under the supervision of J.M. Prausnitz.

"The NRTL equation was derived ten years ago, at a suitable time to respond to a demand. Computers were becoming readily available in the university and industry. Extensive data reduction and calculation of separation processes (e.g. distillation, absorption, and liquid extraction) became possible for fluid mixtures taking into account deviations from ideality in the calculation of phase equilibria.

"The NRTL equation has the advantage of containing an adequate number of parameters (three at a given temperature) to give a good representation of strong deviations from ideality, including liquid-liquid equilibria, for all types of nonelectrolytic systems. Its extension to multicomponent mixtures does not require additional parameters — only parameters for binary interactions need to be known to calculate the property of any mixture of nonelectrolytes.

"The article gives a derivation of the equation, its practical advantages, a summary of its extensive application to phase equilibria representation and a comparison with other equations.

"The manuscript received good reviews and was accepted after minor revisions.

"The new equation was rapidly and widely accepted for industrial applications: computer data bank and chemical process studies. The article is often referred to because of its application to the reduction of vapor-liquid and liquid-liquid data for process calculations and because of many attempts to modify and improve the original equation. NRTL parameters are now published systematically in data collections along with experimental data.

"In the research effort which gave me the opportunity to find the equation, the merit of John M. Prausnitz is immense He had just completed a monograph with three other students on calculation of vapor-liquid equilibria. He succeeded in inspiring each of his students to work on a topic where a step forward was possible and expected There were adequate library and computer facilities on the Berkeley Campus of the University of California; there were many able graduate students for discussion and many professors were generous with their time [But the exceptional quality of John's leadership was the major factor for success.

"I take the opportunity to thank the directors of Institut Francais du Petrole who allowed me to spend three years in California to accomplish a research program for which I was well prepared by French graduate studies in engineering, emphasizing fundamentals."