two-scale approach may be used to present a unified theory of homogeneous and heterogeneous reactors!)

To summarize, the two-mode models are the *minimal models* that provide a low-dimensional description of mixing, by coupling the interaction between chemical reaction, diffusion, and velocity gradients at the local scales to the macro-scale reactor variables. Due to their simplicity and generality, it is hoped that they will find applications in the preliminary design and optimization of homogeneous chemical reactors, as well as provide an alternative method for teaching micromixing effects in homogeneous reactors.

ACKNOWLEDGMENTS

This work was supported by grants from the Robert A. Welch Foundation, the Texas Advanced Technology Program, and the Dow Chemical Company. We thank David West of Dow Chemical, Dr. Grigorios Kolios of the University of Stuttgart and Prof. Dan Luss of the University of Houston for their help in locating and translation of the articles by Bodenstein and Wolgast and Förster and Geib.

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ChE letter to the editor

Dear Editor:

I recently used the illustration below to explain the benefits of countercurrent flow to students in a separation processes subject that I teach. I've never heard this illustration used before and it seems to be a good one, so I thought it would be good to put it in the public domain for the benefit of other lecturers. However, it is very short and does not warrant being a "peer-reviewed" paper.

Explaining Why Counter-Current is More Efficient than Co-Current

While washing the dishes one night, I realized that this activity provides a useful everyday illustration of why countercurrent mass and heat transfer processes are more efficient than co-current ones.

I asked the students in my class what would be the best way to clean a pile of dirty dishes if they had at their disposal one basin of dirty wash water and one basin of clean wash water. The class quickly reached the consensus that it would be best to first use the dirty water to clean off as much of the dirt as possible and then use the clean water to perform a second-stage clean. The dirty water would remove the bulk of the dirt, minimizing the contamination of the clean water and leaving it in better condition to clean off any remaining stubborn dirt. Putting the dirty dishes straight into the clean water would quickly dilute and waste its cleaning ability.

This is equivalent to having the countercurrent flow of streams in a liquid-liquid extraction or gas-liquid absorption column. The clean solvent is best used to perform the final stage of cleaning, while the used solvent is still able to perform some cleaning of the raw feed stream as it enters the column.

Students seemed to intuitively understand this illustration, and it provides a non-graphical complement to the usual method of explaining the benefits of countercurrent flow, which involves showing how the average concentration (or temperature) difference driving force differs between co- and countercurrent flows.

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