

118f The Catalytic Pellet: a Rich Learning Environment for Scaling

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Multiple scale process and multiphase systems have been of relevance in Chemical Engineering from the beginning of the profession. In today technology, the nano- and micro-scale processes have highlighted even more the need for the students to understand scaling. This is, of course, covered in courses at the undergraduate and grad level, in general, by using the “scaling factors” and the “geometrical similarity” in many cases. While this maybe useful for the design of a device or apparatus, it lacks of the basis for using the fundamental principles of conservation and transport of momentum, mass, and energy. Furthermore, catalytic pellets, for example, have been modeled in the literature (see, for example, Levenspiel, Fogler, Carberry textbooks) by “hiding” the scaling problem and presenting, therefore, “macroscopic” equations that usually left the students (and faculty) confused about the model and the physics that this model needs to capture. We believe that we can do better.

The catalytic pellet (CP) is a wonderful environment for a POK (Arce, 1994a&b; Arce 2000) to learn scaling in multi-scale process. First, we need to recognize that the pellet is at an intermediate scale between the reactor scale and the more refine pore scale. Second, we need to describe the physics of the process taking place in a heterogeneous catalytic system as it is from the physical and chemistry points of view. Third, we need to help the students to model this physics and chemistry with the mathematical tools that they learned in calculus and other applied math courses. Fourth, students need to extract information that is useful for the macroprocesses and fifth, students need to reflex about the validity of the scaling process and understand the limitations and implications.

The authors will present a methodology based on fundamental principles and rigorous modeling approaches to describe the physics of the process and then, by scaling arguments based on a process of volume-averaging will arrive to “traditional equations” that now are systematically derived. In short, the five steps identified above are integrated in the learning approach. No story telling, no hidden process, and no misunderstanding of the physics and math used in the modeling is present in the approach. The authors will share experiences from different places, i.e. the FAMU-FSU College of Engineering, Tennessee Tech, the UCN (Chile) and California Davis. Also, they will discuss the placement of the CP as a viable POK for learning multi-scale processes similar to the ones used in today applications.

References:

1. Arce, P., “Topics in Transport and Reaction in Multiphase Systems,” Chemical Engineering Education, Fall 1994a Issue, 224-230.
2. Arce, P. “The Colloquial Approach: An Active Learning Technique,” Journal of Science Education and Technology, 3 (3), 145, (1994b).
3. Arce, P., “Principal Objects of Knowledge (POK's) in Colloquial Approach Environments,” Annual Conference Proceedings, American Society for Engineering Education, ASEE (2000).