Integrating Computational Transport Phenomena into the Undergraduate Chemical Engineering Curriculum

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EXTENDED ABSTRACT

Computational Fluid Dynamics (CFD) and visualization tools have advanced to the point where commercial CFD software can readily be integrated into the engineering curriculum. These enabling technologies portend a paradigm shift in how next generation undergraduate students will learn about momentum, heat, and mass transfer in reacting and non-reacting fluids. CFD simulations provide a means for understanding physical phenomena and for discussing the consequences of commonly employed design decisions in single phase and multiphase flows. This paper illustrates the practical utility of using CFD to explore the boundaries of traditional transport phenomena problems commonly employed in the undergraduate curriculum and complements an earlier introductory paper on the topic (see Moeykens et al., 2004).

Faculty and graduate students at Michigan State University are using Flowlab (www.flowlab.fluent.com) as a teaching aid with freshman, sophomore, and junior level chemical engineering students. Prototypical examples are used to complement specific lectures and/or analysis of experimental data in the laboratory related to unsteady state heat transfer, developing flow in a pipe at low Reynolds numbers, expanding flow in a pipe, radial flow between parallel disks, and batch sedimentation. Figure 1 illustrates results recently developed by students for the entry length problem in pipe flow. This interesting example, and others, will be used to illustrate how a CFD "experiment" can be used to support a classroom discussion about the physical nature of transport phenomena and the limitations of empirical correlations.

Moeykens, S., M. Krishnan, J. S. Curtis, C. Petty, F. Stern, and A. Rothmayer, 2004, Introducing Computational Fluid Dynamics to Undergraduate Engineers, AIChE Annual Meeting, San Francisco, CA, November 16-17, 2004.

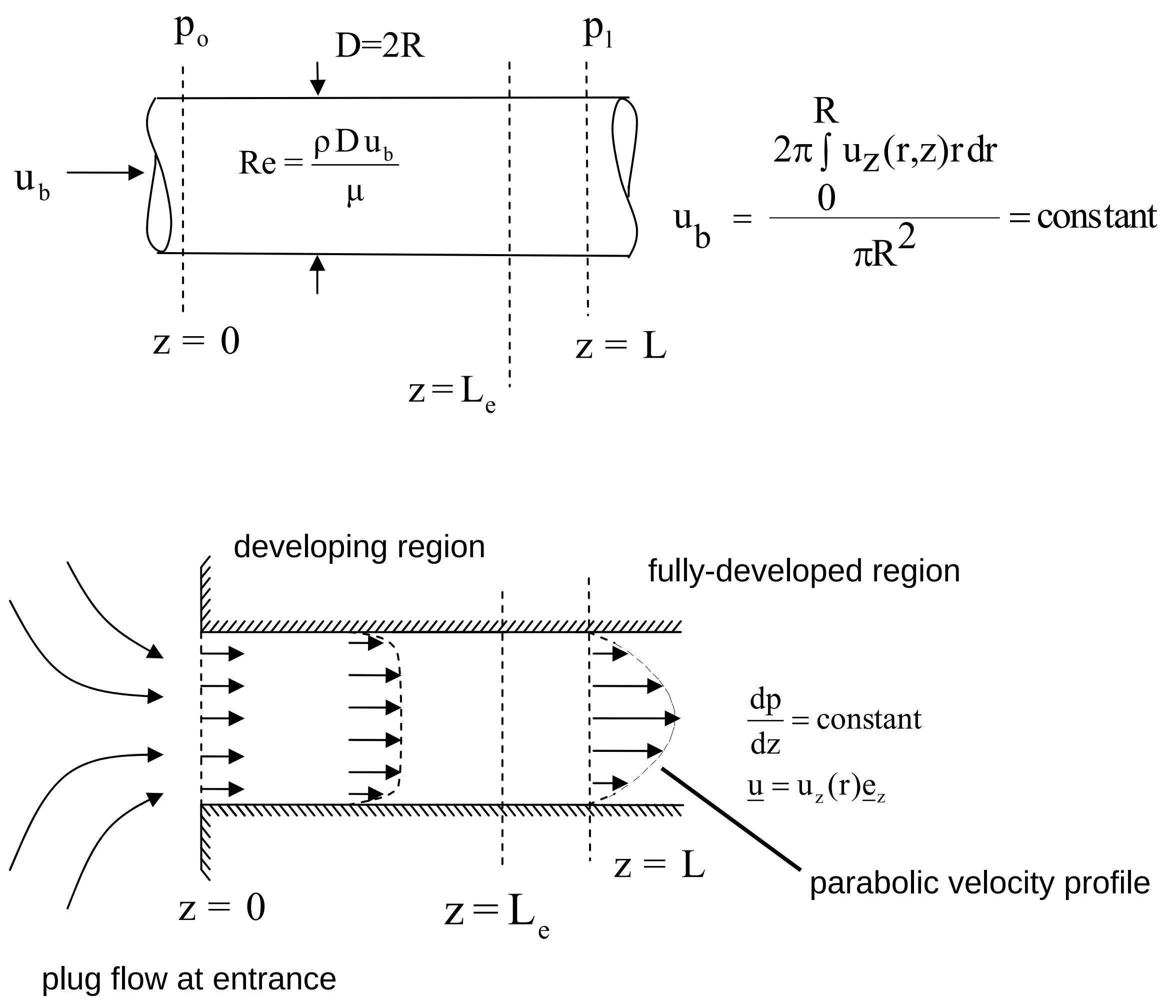

Figure 1. Schematic of Entry Length Problem

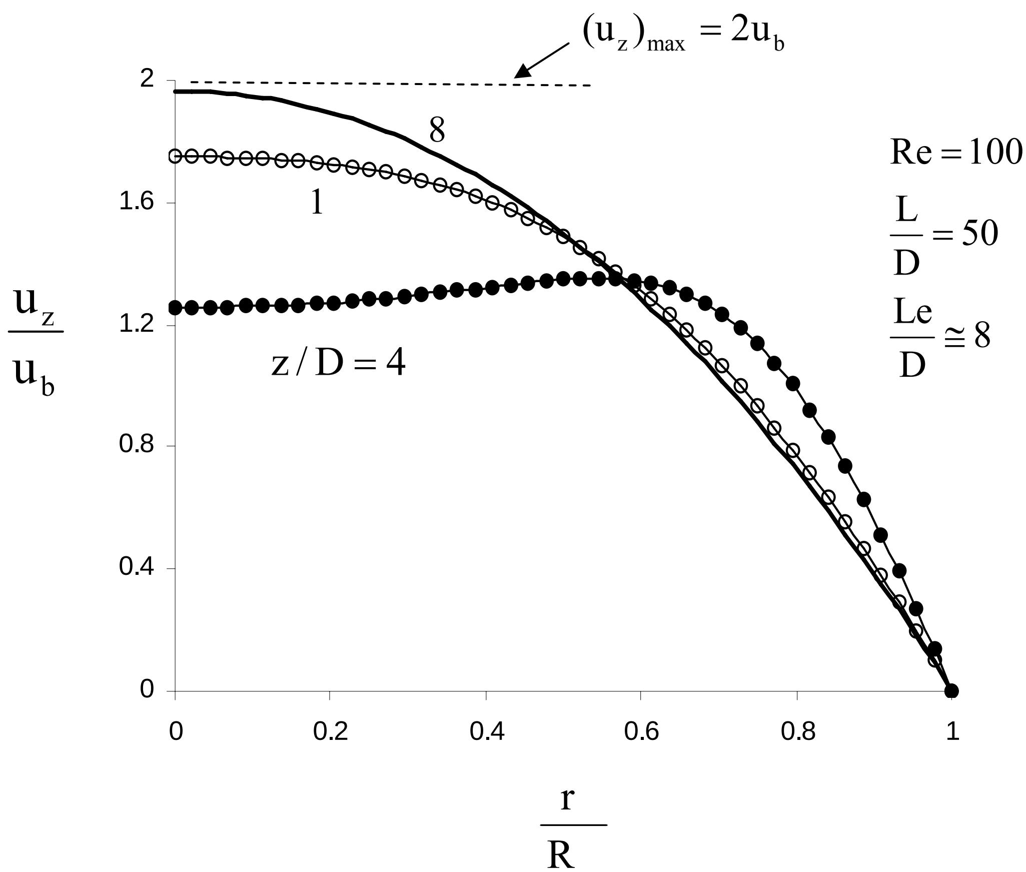

Figure 2. Developing Axial Velocity Profiles

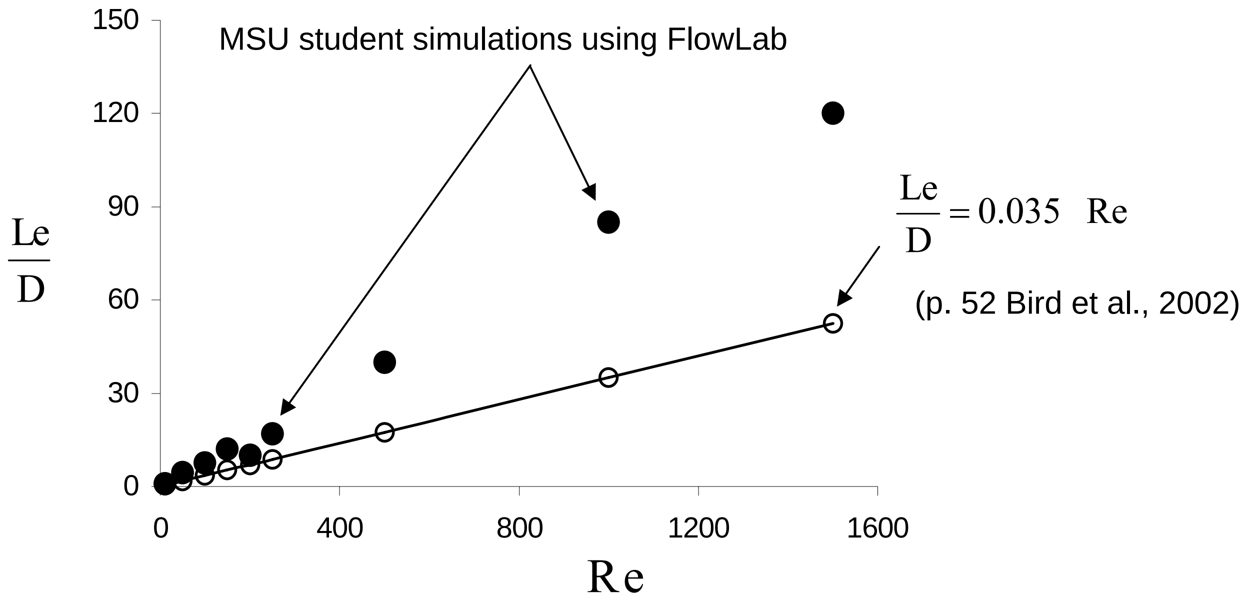

Figure 3. Entrance length for fully-developed pipe flow