Available online at www.sciencedirect.com
SCIENCE DIRECT®

PERGAMON

International Journal of Multiphase Flow 29 (2003) 719–720

International Journal of Multiphase Flow

www.elsevier.com/locate/ijmulflow

Letter to the Editor

CMFD (a brand name) and other acronyms

The term Computational Fluid Dynamics (CFD) has been in use for a long time. I did not find any fully satisfactory definition of the term. It is, however, well accepted now as the third "leg" of fluid dynamics, next to theory and experimentation. It is in any case the combination of Fluid Mechanics theory with Computational Methods to solve complex fluid dynamics problems. Turbulence is often considered and is usually "modeled," although Direct Numerical Simulation (DNS) methods—applicable for the time being only to very simple cases—claim to resolve all scales of fluid movement and simulate turbulence, eliminating the need for turbulence models.

Computational methods have been applied to multiphase flow problems for a long time. Sophisticated numerical techniques and the theory of multiphase flows indeed developed in parallel; one of the driving forces was the need to compute problems where large-scale experimentation was not easy or even possible; a prime example is the calculation of complex transients in Light Water Reactors, a requirement that has vigorously driven developments. These multiphase flow computations were, however, mainly one-dimensional, the exact shape of the interfaces was ignored and phases were described most often as interpenetrating media; turbulence was largely neglected. The one-dimensional "two-fluid model" is the modern working horse in this area.

More recently, publications appeared where these limitations are being removed, one by one. Interface tracking methods allow us now to compute the shape of structures such as bubbles, to track (still small) clusters of bubbles, or the configuration of the phases, with some more effort maybe determine the flow pattern. Bubbly flows where turbulence in the liquid phase, partly attributable to the bubbles, plays a determining role have been successfully tackled, mainly using the classical Reynolds Averaged Navier Stokes (RANS) methods, so far. Even more promising seems to be the use of Large-Eddy Simulation (LES) to capture the turbulent interactions between bubbles and the large eddies in the continuous phase. The interaction of turbulence with small particles has also been extensively studied. The techniques applied for these developments were "CFD like" in the sense that they were based on the well-established bases of Fluid Mechanics, were three-dimensional, often considered the turbulence, and used computational techniques; in complexity and difficulty, they are, however, clearly one step beyond the classical CFD of single-phase flows. As it happened for single-phase flows, numerical experimentation is again providing an alternative to laboratory investigations in multiphase flow situations.

These new techniques need, I feel, a "brand name." In the summer of 2001, during the European Two-Phase Flow Group Meeting, a few of us were walking in the streets of Stockholm and offering alternatives. I proposed "Computational *Multi*-Fluid Dynamics" or C*M*FD. My colleagues liked it and I started using the acronym. Hopefully, it can catch and become the brand name for this very promising, still emerging field. This journal, the primary medium for

0301-9322/03/$ - see front matter
doi:10.1016/S0301-9322(03)00034-X

disseminating new developments in multiphase flows, could open a dialogue on the name and the subject.

PS: One more remark. Some of us have been referring to two-phase flow computations (such as tracking of interfaces) as DNS; the justification is that no models are used, just like in the DNS of turbulent flows. However, turbulence and the need to resolve all scales of fluid motion are not necessarily involved in these problems; therefore, I find use of the term not really justified. The rationalization "absence of models" is not tenable; in the same light all laminar or potential flow problems would also have been DNS ...

G. Yadigaroglu
Swiss Federal Institute of Technology
ETH-Zentrum/CLT
8092 Zurich, Switzerland
Tel.: +41-1-632-4615; fax: +41-1-632-1166
E-mail address: yadi@ethz.ch