

Preface

Sometime in 1983 four of us, Sanjoy Banerjee, Gad Hetsroni, Geoff Hewitt and George Yadigaroglu met and decided to organize a Short Course on multiphase flows, following the model that had been successfully tested at Stanford University previously (1979–1983). George Yadigaroglu was appointed the local organizer in Zurich. This was the beginning of a great “enterprise” that is still going on. The first Zurich Short Course took place in March 1984 and an unexpectedly large number of persons participated. Zurich turned out to be an excellent venue and we are grateful to ETH Zurich for hosting the course in its excellent facilities. The audiences kept growing and over 2000 participants took part in the Zurich courses until now. The courses that are still offered—obviously with new material and some new lecturers—became an initiation rite for the junior staff of the research and engineering departments of large companies, national laboratories, university laboratories, etc. Beginners, doctoral students, as well as their professors, young and older scientists, and engineers attended.

In March 2015, Gad Hetsroni died after a short illness. He had a very protective love for the Short Courses and had been the main organizer of the earlier sessions in California. He was involved as a Course Director and Lecturer up to 2015 and material from his lectures is included in these published Zurich notes. We wish to place on record our sincere appreciation of the crucial role he had played.

The Zurich Short Courses not only offered the opportunity to the participants to meet and interact with outstanding lecturers, but also with colleagues working worldwide on similar topics but in different industries. An aim of the courses was to promote interdisciplinary information exchanges between various industries and areas where multiphase flows are important but communications poor. For the lecturers also, the annual meetings became excellent opportunities to meet and interact.

The courses started with the four founders mentioned above, but soon the number of lecturers was expanded: we tried to attract not only the best specialists in their areas but also good communicators and teachers. In 1989, two parallel sessions were offered and the course became modular. The first three days were devoted to Basics while on Thursday and Friday the participants could choose

between two options. Part A was always the “nuclear” one, as many participants came from nuclear industries, even when their particular research interests were not necessarily in the narrower nuclear area. Part B, in response to the increasing interest in computational modelling and computational multi-fluid dynamics, was fully devoted to these topics. In fact, the computational aspects became gradually more important *throughout* the course, reflecting on-going changes and progress. From 2005 on, the course was enriched by bringing in the practical experience of the commercial code developers. By then the number of lecturers was expanded from the initial four to over a dozen.

Today the courses are organized in this modular form as an intensive introduction for persons having basic knowledge of fluid mechanics, heat transfer and numerical techniques and also serve as advanced courses for specialists wishing to obtain the latest information in the field; this series of books has the same goal. In 2007 introductory tutorials were used for the first time; they were mailed to the participants before the course to introduce the very basic concepts, fill any gaps in their basic background and prepare them for the tough week of lectures to come: four to five hour-and-a-half lectures per day. Tutorials are also appended to the volumes now.

The four principals met after each course to organize the next one: Geoff Hewitt always wrote the next outline. Obviously the lectures have evolved over the years, older material had to be shed to make place for new knowledge. The emphasis on the various topics also changed. After some 35 years of Short Courses, an impressive amount of material had accumulated. We finally decided to print the notes in book form, also allowing use of the new electronic means of disseminating the information. We are grateful to Springer that was interested in publishing this material as a series. We are assembling the lecture notes in thematic volumes: basics, conservation equations and closures, phenomenological modelling, boiling heat transfer, two-phase flow dynamics, multiphase flows in the nuclear industry, computational multi-fluid dynamics, etc. The present volume is the first of the series. We expect our volumes to be of interest to scientists and engineers working in the great variety of industries, thermal, chemical, nuclear, petrochemical, food, pharmaceutical, oil-and-gas, etc. where multiphase flows are ubiquitous.

The chapters of the volumes, although initially reflecting the state of the art at the time they were originally written, have been continuously updated over the years and fully updated again for this publication. Although most of the material can be found in the notes distributed to the participants over the years, it has been rearranged to better fit the format of a book. The final result approaches the form of a handbook or a series of textbooks; the pedagogical aspects remain very present. The best parts of lectures (often given by different persons) were re-assembled in the newly updated chapters that continue representing the state of the art.

The reader should not be surprised if a lot of original, old, seminal work is referenced: we prefer to cite the original author and work rather than its latest mention or presentation in a recent paper or textbook; this may make some of the references look “old” but they have been included only if their value has passed the test of time. Throughout the chapters, we insist on understanding of the physics and

on mechanistic modelling while not ignoring the empirical, well-established methods as well as the numerical applications. Our approach is to start from the basic principles and ideas and to progress gradually, ending up with the state of the art and occasionally looking beyond. A special effort is made to remain as educational as possible.

A few words about the present volume on *Introduction to Multiphase Flow* and Basics: After introducing the reader to multiphase and in particular two-phase flows, the basic concepts, variables, notions and tools necessary for the following chapters are introduced in Chap. 1. Chapter 2 discusses the various alternatives available for *modelling* and studying analytically or numerically two-phase flows. The more advanced alternatives are simply surveyed in this chapter as they need more in-depth and formal treatment in other volumes. Chapter 3 is an introduction to the *interfacial instabilities* that govern a multitude of two-phase flow phenomena; the early introduction of this material will help the following presentations. A long Chap. 4 covers in depth the *flow regimes*, a special characteristic of two-phase flows that governs their mechanistic modelling; consequently this chapter gives an excellent opportunity to introduce the reader to phenomenological modelling. Finally, Chaps. 5 and 6 cover *void fraction* and *pressure drop* in two-phase flow, two topics that are of particular concern to any designer or analyst of two-phase equipment and systems.

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