

ANNOUNCEMENTS

MULTIPHASE FLOW AND HEAT TRANSFER: BASES, MODELING AND APPLICATIONS

A 5-DAY WORKSHOP

Hosted by

Department of Chemical and Nuclear Engineering, The University of California,
Santa Barbara, U.S.A.

27 September–2 October 1992

THE PROGRAM

Two-phase flow and boiling heat transfer continue to focus the attention of researchers and to frustrate and challenge the engineer in the chemical, nuclear, oil-and-gas, cryogenic and other industries. New data and information, ideas and hypotheses, and facts and erroneous theories continue to be produced.

The short course described here is patterned after similar courses offered for a number of years at Stanford University and more recently at the University of California—Santa Barbara and at ETH—Zurich. Its intent is to provide:

- A condensed and critical view of present knowledge including areas of uncertainty.
- Transfer of knowledge from one area of application to another.
- Sources of data and correlations.
- System analysis and design philosophy and methods.
- Limitations of modern codes will be pointed out.

The course features:

- A program of coordinated lectures by experts in the field.
- A complete set of lecture notes and copies of slides.
- Movies to illustrate physical phenomena.
- Limited enrollment.

Course Directors

G. Hetsroni and S. Banerjee.

The Lecturers

Sanjoy Banerjee, Gad Hetsroni, Geoffrey F. Hewitt, Salomen Levy and George Yadigaroglu.

CONTENTS OF THE LECTURES

Monday, 28 September

1. **Introduction and Basics:** *G. Hetsroni.* Nature of multiphase flows. Definition of basic quantities. Basic concepts of control volume averaging. Homogeneous and mixture models.
2. **Basic Equations:** *S. Banerjee.* Averaging and derivation of conservation equations. Time and space dependent effects. Virtual mass. Multifluid models. Drift flux model. Requirements for closure relationships.
3. **Flow Regimes, Pressure Drop and Void Fraction:** *G. Hetsroni.* Description of flow regimes. Flow regime maps. Analytical bases for the flow regime transitions. Pressure drop and void fraction in various flow regimes.
4. **Phenomenological Modeling: Continuous Flow:** *G. F. Hewitt.* Bubble flow: drift flux correlations, void profile, turbulence, coalescence. Stratified flow: simple and more advanced models, turbulence. Annular flow: basic theory, entrainment and deposition, modeling, applications.

Tuesday, 29 September

5. **Phenomenological Modeling: Intermittent Flow:** *G. F. Hewitt*. Plug flow: bubble rise velocity, mechanisms, stability. Churn flow: mechanisms, interpretations, modeling. Slug flow: fluid behaviors in slugs, slug frequency and velocity.
6. **Closure Relationships:** *G. Yadigaroglu*. Interfacial area. Wall and interface friction. Relationships between void fraction and interfacial friction. Interfacial heat transfer. Empirical closure laws.
7. **Two-phase Heat Transfer:** *G. Hetsroni*. Boiling heat transfer: nucleate boiling, forced convection. Correlations and models. Dryout (critical) heat flux: mechanism and prediction.
8. **Post-dryout Heat Transfer and Rewetting:** *G. Yadigaroglu*. Description of physical phenomena: importance of departures from mechanical and thermal equilibrium. Dispersed flow film boiling: drop size spectrum and distributions. Various types of rewetting phenomena.

Wednesday, 30 September

9. **Numerical Methods:** *S. Banerjee*. Initial and boundary conditions. Method of characteristics. Finite difference methods. Stability. Explicit and implicit methods. Methods used in computer codes.
10. **Flow Limiting Phenomena:** *G. Yadigaroglu*. Critical two-phase flow: basic concepts, difficulties in calculating flow rate due to the nature of two-phase flow. Countercurrent-flow limitations: the flooding mechanisms, models, correlations; importance of geometry and subcooling.
11. **Multidimensional Modelling:** *S. Banerjee*. Basic multidimensional equations. Direct simulation. Large eddy simulation. Turbulence modeling: three-dimensional effects.
12. **Instabilities in two-phase flow:** *G. Yadigaroglu*. Instabilities of the liquid-gas interface. Modes of system instability: fundamentals, mechanisms. The Ledinegg instability, flow distribution instabilities, density wave oscillations etc. Analytical tools, stability maps, BWR stability.

Thursday, 1 October

13. **Computer Codes:** *G. F. Hewitt*. Generic approach in computer codes. Specific codes (RELAP, TRAC FLOW3D, PHOENICS, etc.). Achievements and limitations of codes. Future development and applications in nuclear systems.
14. **Two-phase Phenomena in Advanced Reactors:** *S. Levy*. Key phenomena associated with design of advanced water reactors. Special features arising from evolutions in design. Containment and passive safety aspects.
15. **Condensation Phenomena:** *G. F. Hewitt*. Modes of condensation. Interfacial resistance. Film condensation: gravity controlled and shear controlled. Spray condensation.
16. **Steam Generators:** *G. Hetsroni*. Nuclear steam generators. Design considerations. Operational problems: corrosion, vibration etc. Extension of lifetime. Alleviation of problems. New design concepts and replacement.

Friday, 2 October

17. **Severe Accidents:** *G. Yadigaroglu*. Severe accident scenario and phenomena. Vapour explosions. Debris-bed cooling etc.
18. **Space and Microgravity Applications:** *S. Banerjee*. Two-phase phenomena in microgravity environment: heat transfer and flow regimes. Space boiling and condensation systems.

REGISTRATION INFORMATION

Registration is requested by **1 September 1992**. To request space after this date call (805) 893-4993. No refunds will be granted after this date unless the workshop is cancelled. To secure registration, send registration form plus payment prior to **1 September**.

WORKSHOP FEES

Registration fees are \$1150 (U.S.) and include lecture notes, copies of all slide notes, reception and workshop banquet. The lectures will be conducted at the Sheraton. Because of space limitations, participants are urged to register well before the deadline.

HOTEL INFORMATION

Participants may stay at the Sheraton Santa Barbara at a special room rate of \$89/night. Please contact the hotel directly [Tel: (805) 963-0744 or Fax: (805) 962-0985] and mention the workshop.

FOR FURTHER INFORMATION CALL:

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