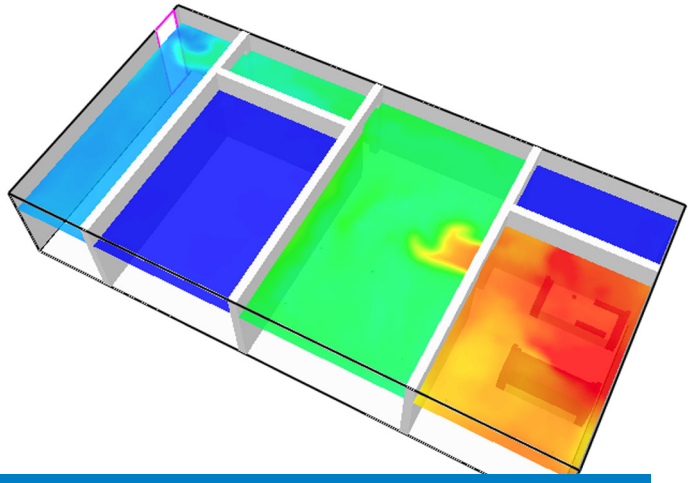
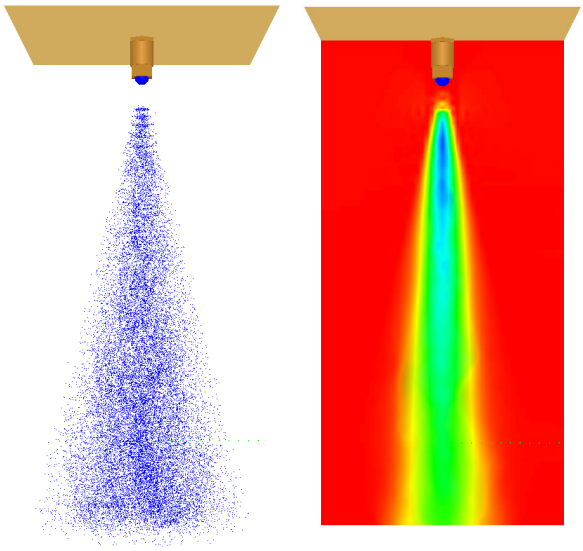
INTRODUCTION TO THE USE OF CFD IN FIRE SAFETY ENGINEERING





POST-ACADEMIC COURSE

22 March 2017 – 28 June 2017

GHENT
UNIVERSITY

INTRODUCTION

Fire protection concepts have been continuously evolving over the years, experiencing nowadays a paradigm shift from a 'prescriptive-based' to a 'performance-based' design. Thanks to the modern and advanced technique of Computational Fluid Dynamics (CFD), performance-based design allows more flexibility (than prescriptive regulations) in meeting the fire protection needs of modern buildings .

The use of CFD requires however solid theoretical knowledge in several physical and numerical aspects, a prerequisite to computer simulations of high quality and reliability. In fact, very often the 'quality' of CFD simulations depends more on the skills and knowledge of the user than on the capabilities of the CFD code itself. This is referred to as the 'user effect'.

This series of lectures at IVPV on the use of CFD in fire safety engineering is proposed by the Ghent University research group of Prof. Bart Merci, a world leader in the field of CFD.

In most of the lectures, general theoretical CFD aspects will be addressed first. These aspects will then be put in practice by considering the set-up and analysis of several cases using a specific CFD package, namely the Fire Dynamics Simulator (FDS 6). Furthermore, two modules will address the practical insights of CFD simulations from a consultancy office and fire service standpoints. Besides, in this new 2017 edition, two extra sessions are scheduled. The first session addresses water spray modelling and the second session is devoted to the detailed set-up of a simulation from scratch.

WHO SHOULD ATTEND?

This program is open to all current and potential CFD users in the field of fire safety (e.g. fire safety engineers and officers) willing to acquire a solid theoretical and practical knowledge in fire computer simulations.

SCIENTIFIC COORDINATION

Prof. Bart Merci, Department of Flow, Heat and Combustion Mechanics, Ghent University

TEACHERS

- dr. Tarek Beji, Department of Flow, Heat and Combustion Mechanics, Ghent University
- ir. Xavier Deckers, Fire Engineered Solutions
- ir. Christian Gryspeert, Fire officer, Fire zone Midwest
- prof. Bart Merci, Department of Flow, Heat and Combustion Mechanics, Ghent University

POST-ACADEMIC COURSE CERTIFICATE GRANTED BY THE GHENT UNIVERSITY

To receive a certificate, one should attend at least modules 1,2, 3 and 6, succeed for the written exam and make a report of the work done in module 6.

PROGRAMME

1. FLUID MECHANICS AND HEAT TRANSFER IN FIRES

- Fluid Mechanics
  - Buoyancy
  - Bernoulli's principle
  - Turbulence
  - Navier Stokes conservation equations
- Heat transfer
  - Convection
  - Conduction
  - Radiation
- Combustion and chemical reactions

Teacher: Bart Merci
Dates: 22 and 29 March 2017

2. INTRODUCTION TO CFD FOR FREELY BURNING FIRES IN OPEN ATMOSPHERE

- Free-field non-reacting buoyant plumes
  - Theoretical background
  - Setting up a case: boundary conditions (inlet + the rest of the domain), creating the mesh and turbulence modelling
  - Analysing a case: velocity field, temperature field
- Open atmosphere freely burning fires
  - Combustion modelling: reaction rates and species production
  - Prescribed burning (Decoupled solid/liquid and gas phase): theoretical background, case set-up and analysis (i.e. velocity, temperature, flame height, thermal radiation)
- Fire spread
  - Theoretical background (heat-up and ignition)
  - Case set-up
  - Analysis (i.e. velocity, temperature, flame height, thermal radiation)

Teacher: Tarek Beji
Dates: 19 and 26 April and 3 May 2017

3. INTRODUCTION TO CFD FOR FIRE DYNAMICS AND SMOKE MOVEMENT IN ENCLOSURES

- Natural ventilation
  - Theoretical background
  - Set-up of two cases (vertical and horizontal vents): boundary conditions (inlet + the rest of the domain), creating the mesh and monitoring devices
  - Analysis: data reduction in terms of two zone-modelling (smoke layer height, layer temperatures)
- Mechanical ventilation
  - Theoretical background
  - Set-up of a case: boundary conditions (inlet + the rest of the domain), creating the mesh and monitoring devices
  - Analysis of the case
- Mechanical ventilation in confined enclosures
  - Theoretical background: pressure effects (pressure zones, fan curves, leaks)
  - Set-up of a case
  - Analysis of the case
- Water sprays
  - Theoretical background: spray boundary conditions
  - Set-up of a case
  - Analysis of the case

Teacher: Tarek Beji
Dates: 10, 17, 24 and 31 May 2017

4. CFD IN FIRE SAFETY ENGINEERING FROM THE PERSPECTIVE OF A CONSULTANCY BUREAU

This lesson will take a look at the common applications of CFD in Fire Safety Engineering, and rank them in terms of difficulty/responsibility by the fire engineer.

- Standard CFD
  CFD-calculations are often applied in order to show the good performance of a smoke control system. Some standards (e.g. NBN S21-208-2) prescribe all the parameters required as input in your simulations. What is required from the engineer? Which levels of freedom are there? Which questions can not be solved with the standard parameters?
- Performance Based Design
  Many complex buildings require the application of CFD calculations as a tool for helping evaluate the overall safety level. When correctly applied, this gives more insight in a specific fire related flow-problem. FESG will present 2 case-studies where complex smoke control systems were designed. What is the responsibility of the engineer and what sensitivity studies are typically required?
- Quantitative Risk Assessment
  The use of CFD in quantitative risk assessment is quickly progressing. Which factors need to be included and how can the overall risk level be described? FESG will present 2 case-studies which will show the added value of CFD in QRA, when correctly applied.

Teacher: Xavier Deckers
Date: 7 June 2017

5. CFD IN FIRE SAFETY ENGINEERING FROM A FIRE FIGHTING PERSPECTIVE

Fire brigades are interested in the global safety concept. Mostly CFD is used as a tool to "prove" a certain level of safety. It is important to understand how fire officers look at CFD calculations. Examples will show some good practice.

CFD can be a very useful tool in the education of fire fighters. Examples will demonstrate the use of CFD in understanding the behaviour of fire in different ambient conditions. Especially the influence of ventilation (opening/closing doors, activation of positive pressure ventilation,...) is studied.

Teacher: Christian Gryspeert
Date: 14 June 2017

6. SET-UP OF A COMPLETE TEST CASE FROM SCRATCH & ASSIGNMENT

- Set-up of a complete test case from scratch
  - Description of the Steckler test case
  - Set-up
  - Analysis of the results
- Assignment
  - Definition of a test case of interest to the candidate
  - Set-up of the case (1 class session to guide the students)
  - Analysis + Submission of a report

Teacher: Tarek Beji
Dates: 21 and 28 June 2017

MORE INFORMATION & SUBSCRIPTION

www.ivpv.ugent.be/CFD

PRACTICAL INFORMATION

FEE

The fee includes the tuition fee, course notes, soft drinks, coffee, sandwiches and the reference book. For participants who follow all modules the fee also includes the reference book. Payment occurs after reception of the invoice. All invoices are due in thirty days. All fees are exempt from VAT.

1. Fluid mechanics and heat transfer in fires	€ 300
2. Introduction to CFD for freely burning fires in open atmosphere	€ 450
3. Introduction to CFD for fire dynamics and smoke movement in enclosures	€ 600
4. CFD in fire safety engineering from the perspective of a consultancy bureau	€ 150
5. CFD in fire safety engineering from a fire fighting perspective	€ 150
6. Set-up of a complete test case from scratch & assignment	€ 300
All modules	€ 1.800

REDUCTION

- When a participant of a company subscribes for the complete course, a reduction of 20% is given to all additional subscriptions from the same company, even on single lessons. Invoicing is then done by one company invoice.
- AIG and VBIG members receive a reduction of 10% on the prices mentioned in the table.
- Fire departments receive a reduction of 20% on the prices mentioned in the table.
- Special prices for Ghent University staff and members of Ghent University Association.
- Reductions can't be combined.

CANCELLATION POLICY

When cancelling up to 10 days before the start of the course or module 25% of the participation fee will be charged. When cancelling less than 10 days before the start of the module, the full fee is due.

TRAINING CHEQUES

Ghent University accepts payments by KMO-portefeuille (www.kmo-portefeuille.be; authorisation ID: DV.0103194).

TIME AND LOCATION

- The lessons are given from 16h30 till 20h00 with a sandwich break.
- Location: building 904, Technologiepark, Zwijnaarde.
- Dates may change due to unforeseen reasons.

LANGUAGE

English is used in all presentations, exercises and documentation, so ready knowledge of English is necessary.

REFERENCE BOOK

The reference book ' Fluid mechanics aspects of fire and smoke dynamics in enclosures' (Merci & Beji, 2016) is included in the fee for participants who follow all modules.
Other participants can buy this reference book (80,95€ including VAT) (facultative). This book is billed directly by the bookshop.

MORE INFORMATION & SUBSCRIPTION

www.ivpv.ugent.be/CFD

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GHENT UNIVERSITY

FACULTY OF BIOSCIENCE ENGINEERING

FACULTY OF ENGINEERING AND ARCHITECTURE