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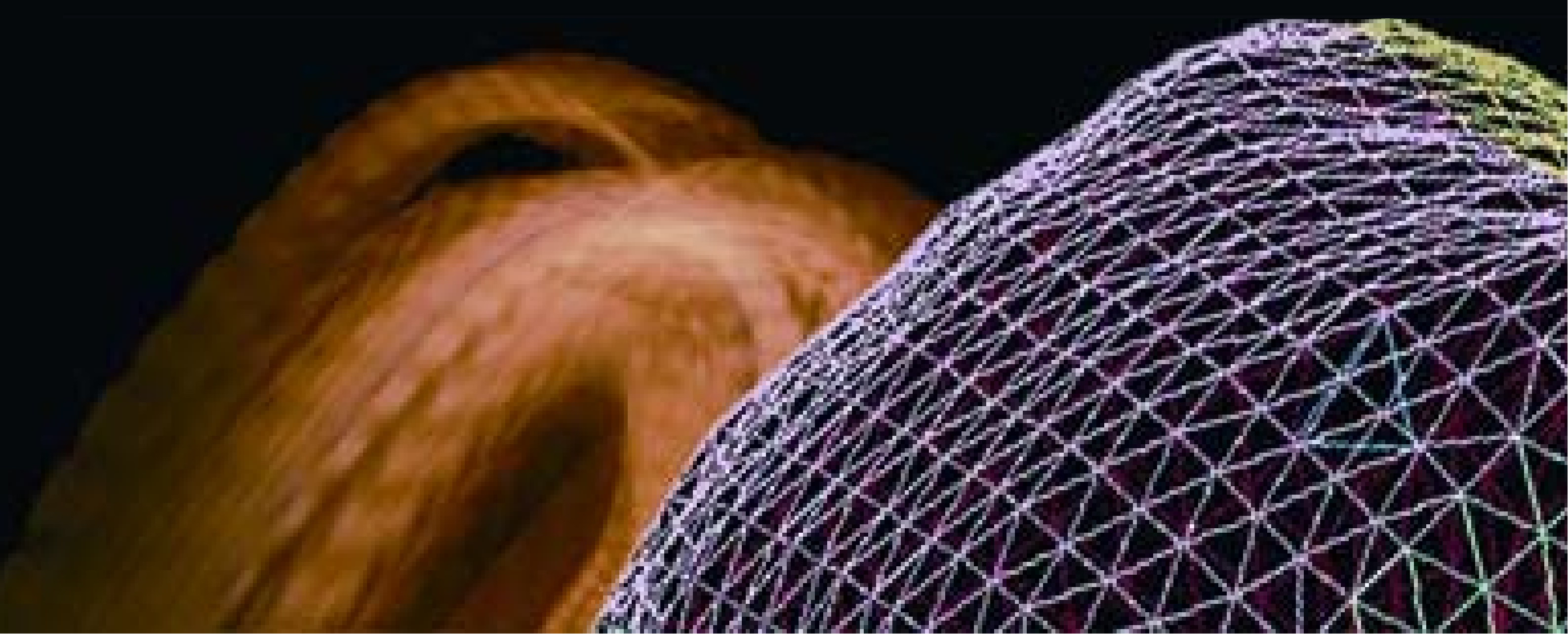
MULTIPHYSICS 2015

10 - 11 December 2015
London, United Kingdom



MULTIPHYSICS 2015

10-11 December 2015
London, United Kingdom

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General Information

Scope of Conference

Understanding real physics and performing Multiphysics simulation are extremely important to analyse complex systems in order to better design and manufacture engineering products.

The objective of the conference is to share and explore findings on mathematical advances, numerical modelling and experimental validation of theoretical and practical systems in a wide range of applications.

The scope of the conference is to address the latest advances in theoretical developments, numerical modelling and industrial application, which will promote the concept of simultaneous engineering. Typical combinations would involve a selection from subject disciplines such as Acoustics, Electrics, Explosives, Fire, Fluids, Magnetic, Nuclear, Soil, Structures, and Thermodynamics.

Registration Pack – Collection Hours

Registration packs should be collected from the Registration Desk. Collection Hours are as follows:

Thursday, 10th December	9:30-17:30
Friday, 11th December	9:30-17:30

Special Events

Thursday, 10th December Group Photograph	11:00
Thursday, 10th December Conference Banquet	19:30

Timing of Presentations

Each paper will be allocated 20 minutes. A good guide is 15 minutes for presentation with 5 minutes left for questions at the end.

Good timekeeping is essential, speakers are asked to keep strictly to 20 minutes per presentation.

Group Photograph

A group photograph will be taken during the tea/coffee break on the first day of the Conference.

Language

The official language of the conference is English.

Audio-visual

The lecture room will be equipped with the following: One laptop, one LCD projection and cables, one screen, and one microphone.

Delegates are requested to bring presentations on a memory stick.

Paper Publication

Authors will be invited to submit full length papers for publication in 'The International Journal of Multiphysics' by 31st January 2016.

Sponsorship

The Conference Board would like to thank the sponsors for their support.

Keynote Speaker

Prof. Christopher Pain
Imperial College London
United Kingdom

BIOGRAPHY

Prof. Christopher Pain is head of the Applied Computation and Modelling Group (AMCG) of about 50 scientists and engineers at Imperial College and co-leads the Novel Reservoir Modelling and Simulation group (NORMS), at Imperial College. His main academic interests are in general Computational Fluid Dynamics (including multiphase flow in porous media, industrial multi-phase flows, oceanography and geophysical fluid dynamics), nuclear engineering (neutron and photon transport, nuclear criticality, nuclear reactor dynamics, nuclear waste repositories), optimisation, data assimilation, sensitivity analysis, reduced order modelling, parallel solution techniques. Professor Pain has supervised 37 successful PhDs and published 170 journal papers.

MULTIPHYSICS 2015

PROGRAMME

TIME	Thursday 10 December 2015	Friday 11 December 2015
09:30 - 10:00	**Registration**	
10:00 - 11:00	**Keynote Address**	**Session 2.1** *Advanced Modelling Techniques*
11:00 - 11:30	**Tea/Coffee Break**	
11:30 - 13:00	**Session 1.2** *Thermohydraulics*	**Session 2.2** *Impact and Explosions*
13:00 - 14:00	**Lunch**	
14:00 - 15:30	**Session 1.3** *Radiation Transport & Accident Modelling*	**Session 2.3** *Aviation and Automotive*
15:30 - 16:00	**Tea/Coffee Break**	
16:00 - 17:30	**Session 1.4** *Posters*	**Session 2.4** *Applications in Multiphysics*
19:30	**Banquet**	

Full Programme

Thursday 10 December 2015

09:30 – 10:00 Registration

10:00 – 10:15 Conference Opening

Opening of The 10th International Conference of Multiphysics 2015
Mr Hiroshi Matsuura, Minister (Economics), Embassy of Japan in the UK

10:15 – 11:00 Session 1.1
Keynote Address

Chair: M Moatamedi, The International Society of Multiphysics

Fluid, Solid and Radiation Modelling in Multiphysics Systems
Prof. Christopher Pain, Imperial College London, UK

11:00-11:30 Tea/Coffee Break & Group Photograph

Thursday 10 December 2015

11:30-13:00 Session 1.2
Thermohydraulics

Chair: P. Smith, AMECFW, UK

Store Design: From Concept to Operation using CFD

S. Graham, National Nuclear Laboratory, UK

Using Computational Fluid Dynamics to Model Hydrogen Stratification Phenomena Relevant to Nuclear Enclosures

J. R. Hoyes, M. J. Ivings, Health and Safety Laboratory, UK and A. Tehrani, Office for Nuclear Regulation, UK

Refined Turbulent Heat Transfer Modelling: 3D CFD for NPP caution lost at Crossroads

D. Laurence, University of Manchester, UK

Thermohydraulic Codes ATHLET-CD and COCOSYS

W. Luther and M. Sonnenkalb, GRS Garching and GRS Cologne, Germany

13:00-14:00 Lunch

Thursday 10 December 2015

14:00-15:30 Session 1.3
Radiation Transport & Accident Modelling

Chair: S. Graham, National Nuclear Laboratory, UK

Directions in Radiation Transport Modelling
P. Smith, AMECFW, UK

Use of massively parallel computing to improve modelling accuracy within the nuclear sector
A. Buchan, Imperial College London, UK

Detailed severe nuclear accident modelling
D. Pavlidis, Imperial College London, UK

Use of massively parallel computing to improve modelling accuracy within the nuclear sector
Ll.M. Evans[a,b], J.D. Arregui-Mena[b], P.M. Mummery[b], R. Akers[a], E. Surrey[a], A. Shterenlikht[c], M. Broggi[d], L. Margetts[b] , (a) Culham Centre for Fusion Energy, Culham Science Centre, UK, (b) University of Manchester, UK, (c) The University of Bristol, UK, (d) Virtual Engineering Centre, STFC Daresbury Laboratory, UK

15:30-16:00 Tea / Coffee Break

Thursday 10 December 2015

16:00-17:30 Session 1.4
Posters

Multiphysics based Condition Monitoring of Composite Materials
H. Xue, P. Sharma, H. Khawaja, UIT The Arctic University of Norway, Tromsø, Norway

Multiphysics Simulation of Infrared Signature of an Ice Cube
H. Khawaja, T. Rashid, O. Eiksund, E. Broadal, K. Edvardsen, UiT-The Arctic University of Norway, Tromsø, Norway

Review on Marine Icing and Anti / De-icing Systems
T. Rashid, E. M. Samuelsen, H. Khawaja, K. Edvardsen, UiT-The Arctic University of Norway, Tromsø, Norway

Multiphysics investigation of Ice Adhesion over a PVC surface
H. Xue, H. Khawaja, UiT-The Arctic University of Norway, Tromsø, Norway

Numerical Approach Of Coupling Vibration Magneto-convection In Nanofluid
S. Kadri, M. Elmir, R. Mehdaoui, Bechar University, Algeria, IMFT of Toulouse, France

The effect of improving the oil extraction of Slovenia production seed by underwater shock wave
K. Shimojima, A. Takemoto, M. Vesenjak, Y. Higa, Z. Ren, S. Itoh, Department of Mechanical Systems Engineering, National Institute of Technology, Okinawa College, Japan

Measuring the Sea Spray Flux using High-Speed Camera
J. Johansen, K. Edvardsen, P. Sharma, H. Khawaja, UiT-The Arctic University of Norway, Tromsø, Norway

Ice Detection Experimentation Setup Using Infrared and Active Heating for Marine Operations
T. Rashid, H. Khawaja, K. Edvardsen, UiT-The Arctic University of Norway, Tromsø, Norway

FE-Modell for Critical Load according the Second Order Theory of Elasticity
M. Mestrovic, Faculty of Civil Engineering, University of Zagreb, Croatia

Optimization of the Performance of a Biomedical Micro-pump
B. Elhouaria, B. Chellali, and B. Mohamed, University of Bechar, Algeria

Making of pressure vessel for food processing by explosive forming
H. Iyama, Y. Higa, K. Shimojima, M. Nishi and S. Itoh, Department of Mechanical and Intelligent Systems Engineering, National Institute of Technology, Kumamoto College, Japan

Effect of a bi-modal dust size-distribution on dust-acoustic cnoidal waves
M. Ishak-Boushaki, D. Djellout, T. Daimellah and R. Annou. Faculty of Physics, Algeria.

Multiphysics Based Numerical Study of Atmospheric Ice Accretion on a Full Scale Horizontal Axis Wind Turbine Blade
M. S. Virk, U. N. Mughal, Atmospheric Icing Research Team, Narvik University College, Norway

Multiphysics Based Design Study of an Atmospheric Icing Sensor
U. N. Mughal, M. S. Virk, Atmospheric Icing Research Team, Department of Industrial Engineering, Narvik University College, Norway

19:30 Conference Banquet

Friday 11 December 2015

10:00-11:00 **Session 2.1**
Advanced Modelling Techniques

Chair: A. Tehrani, Office for Nuclear Regulation, UK

A Multi-physics Approach towards Chemical Process Engineering with the Extended Discrete Element Method (XDEM)
B. Peters, A. Mahmoudi, M. Mohseni, X. Besseron, A. Estupinan University of Luxembourg

OpenFoam based modelling of 3D particle motion and deposition within electro-static fields
G. Boiger, Zurich University of Applied Sciences, Switzerland

Multiscale Modeling of Pollutant Uptake by Mangroves
O. Richter, N. Hoang Anh, University of Technology Braunschweig, Germany

11:00-11:30 **Tea / Coffee Break**

Friday 11 December 2015

11:30 – 13:00 Session 2.2
Impact and Explosions

Chair: B Alzahabi, Kettering University, USA

A Computational Simulation for Soil Surface and Underground Explosion -the effect of different soil characteristics on a fragments behaviour

Y. Higa, Dept. Mech. Sys. Engng.,National Institute of Technology, Okinawa College., H. Iyama, M. Nishi, Dept. Mech. Intel. Sys. Engng., National Inst. Tech., Kumamoto College, and S. Itoh, Emeritus Prof., Kumamoto Univ. & Nat. Inst. Tech., Okinawa College, Japan

Design of pressure vessel for food processing machine by underwater shock wave

K. Shimojima, Y. Higa, H. Iyama，R. Henzan, S. Itoh. Department of Mechanical Systems Engineering, National Institute of Technology, Okinawa College, Japan

An optical observation of shockwave propagation induced by underwater wire explosion

O. Higa, Y. Higa, K. Shimojima, S. Itoh, National Institute of Technology, Okinawa College and A. Yasuda, K. Hokamoto, Institute of Pulse Power, Kumamoto University, Japan

Water freezing phenomena by decompression

T. Watanabe, S. Uchida, M. Nakamura, H. Ohta: Dept. of Ocean Mech. Eng., National Fisheries Univ., Japan and S. Itoh, Okinawa National College of Tech., Japan

13:00-14:00 Lunch

Friday 11 December 2015

14:00-15:30 **Session 2.3**
Aviation and Automotive
(Sponsored by the Association of Aerospace Universities)

Chair: G. Boiger, Zurich University of Applied Sciences, Switzerland

Fatigue Life Estimate of Hitch Cargo Basket Using Model Analysis

E. Al-Bahkali, A. Al-Witry, T. Albahkali, Mechanical Eng. Dep., King Saud University, Saudi Arabia and M. Souli, University of Lille, France

A Green's integral representation of oscillatory motion in fluids for modelling swimming and flapping motions that generate steady forward propulsion.

R. Elmazuzi, E. Chadwick, Mathematics group, School of Computing, Science and Engineering University of Salford, UK

High-Lift Performance and Flow Control for Flying-Wing Unmanned Air Vehicle Configurations Using Leading Edge and Cross-Flow Slots

U. Ali, E. Chadwick, University of Salford, UK

A New Methodology for Fuel Mass Computation in an operating Aircraft

M. Souli, R.Messahel, University of Lille, France, P. Sinou, B. Reynard, Zodiac Aerospace, France

15:30-16:00 **Tea / Coffee Break**

Friday 11 December 2015

16:00-17:30 Session 2.4
Applications in Multiphysics

Chair: E Albahkali, King Saud University, KSA

A Review of Theoretical Efficiency of High Pressure CO2 Transport
S. Jackson, E. Brodal, H. Khawaja, UiT-The Arctic University of Norway, Tromsø, Norway

Experimental and numerical investigation of the tapping of a wine glass
D. Ludwigsen, B. Alzahabi, and D. Knopp, Kettering University, USA

Comparison Between Static and Dynamic Vehicle Stability Models
A. Al-Witry, T. Albahkali, E. Al-Bahkali, Mechanical Eng. Dept., King Saud University, Saudi Arabia and M. Souli, University of Lille, France

A Study on the effect of adding Hitch Cargo Basket to SUVs' Rollover Using Real-Time Nonlinear Model
T. Albahkali, A. Al-Witry, E. Al-Bahkali, King Saud University, Saudi Arabia and M. Souli, University of Lille, France

17:30 Close of Conference

SESSION 1.1

KEYNOTE ADDRESS

THURSDAY, 10 DECEMBER 2015
10:00 – 11:00

CHAIR

M Moatamedi
The International Society of Multiphysics

Thursday, 10 December 2015
10:00 – 11:00

Keynote Address

Fluid, Solid and Radiation Modelling in Multiphysics Systems

Prof. Christopher Pain
Imperial College London
United Kingdom

Here we present an outline of the work by Applied Modelling & Computation Group on development of radiation transport/neutronics, thermal hydraulics/multi-phase flows, and solids mechanics modelling. We present the coupling of these models together with their applications which now cover a range of industrially important, multi-physics phenomena. Current applications include: criticality in fissile solutions, nuclear reactor analysis and accident scenarios, ocean and atmospheric prediction, pollution dispersion through urban environments, single and multi-phase flows and coastal defense structures. To maximise computational efficiency and accuracy, we employ adaptive mesh resolution to perform some of the multi-scale modelling in which the finite element / control volume meshes are optimized to represent the physics. It is shown how errors in the overall solution can be calculated and how this approach can also be used to generate error measures to guide mesh adaptivity/numerical resolution.

As far as fluid-structure interaction modelling is concerned, the Finite Element Discrete Element Method (FEMDEM) is used for resolving the solids. FEMDEM is able to capture non-linear material behaviour and has multi-body and granular media capabilities so that sediment and scour can be modelled at the grain scale. The model Fluidity is used for the CFD. It is a multi-phase model based on arbitrary unstructured finite element meshes and has an anisotropic dynamic mesh adaptivity capability. This allows us to resolve highly complex geometries.

We outline future research directions in multi-physics modelling, an approach to adaptive multi-scale modelling and how this may be linked to predictive modelling including uncertainty quantification, data assimilation and reduced order, or rapid, modelling.

SESSION 1.2

THERMOHYDRAULICS

THURSDAY 10 DECEMBER 2015
11:30 – 13:00

CHAIR

P. Smith
AMECFW
UK

STORE DESIGN: FROM CONCEPT TO OPERATION USING CFD

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Steve Graham, National Nuclear Laboratory, UK

The long term storage of heat generating nuclear material provides significant challenges for the design of a storage facility. Confidence is needed for the nuclear regulatory authorities and the general public that the facility can operate safely, for the spectrum of thermal loads and range of environmental conditions that the store will be subjected to over its operational lifetime. At the National Nuclear Laboratory, Computational Fluid Dynamics (CFD) has been primarily used as a tool to design and simulate the operation of the store from initial design to operation. The physics is complicated since the store depends on passive cooling; the flow regime is invariably neither laminar nor fully turbulent. Information from a variety of sources, including supporting modelling studies, was gathered to accumulate the knowledge on the behaviour of the system. Validation of the CFD model was carried out at various stages of the project, including commissioning trials and an assessment of how the model behaves during conditions that fall outside normal operation. The model has performed reliably to date in providing correct guidance in these areas of investigation. The presentation will lead the audience through the steps in achieving credibility in the modelling approach for a variety of stakeholders, ranging from external peer reviewers to the regulator; and will indicate the challenges overcome in conducting a study over a pragmatic time frame to satisfy these requirements.

Keywords: CFD, Store Design

USING COMPUTATIONAL FLUID DYNAMICS TO MODEL HYDROGEN STRATIFICATION PHENOMENA RELEVANT TO NUCLEAR ENCLOSURES

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A. Tehrani, Office for Nuclear Regulation, Redgrave Court, Bootle, UK

The Fukushima Daiichi accident serves as a recent reminder of the potential consequences of the release and ignition of hydrogen gas in accident conditions in a nuclear power plant. The oxidation of zirconium cladding during a severe accident in a modern Light Water Reactor (LWR) could result in a significant amount of hydrogen being generated. Computational Fluid Dynamics (CFD) models are maturing into useful tools for hydrogen safety analyses. Simulations can be used to predict hydrogen dispersion and deflagration phenomena and help design mitigation strategies. This presentation will describe the validation of a CFD model of hydrogen stratification using data from tests carried out by the French Alternative Energies and Atomic Energy Commission (CEA) and illustrate its ability to provide information on the performance of Passive Autocatalytic Recombiner (PAR) units – devices that can be used to convert hydrogen and oxygen into water vapour. The model validation exercise includes an assessment of the sensitivity of the predictions to the mesh resolution, mesh type, convergence criteria and choice of turbulence model. This leads to a high level of confidence in the model's ability to predict stratified flows – provided a suitable modelling approach is employed. Application of the model to PAR performance is illustrated using a series of simulations based on a test facility operated by Becker Technologies. Results will be presented from simulations carried out to investigate the effects of PAR position (high or low) and initial hydrogen distribution (homogeneous or stratified).

Keywords: Hydrogen, Stratification, Computational Fluid Dynamics, CFD, Model Validation, Passive Autocatalytic Recombiner, PAR

REFINED TURBULENT HEAT TRANSFER MODELLING: 3D CFD FOR NPP CAUTION LOST AT CROSSROADS

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This decade has seen spectacular progress in cold-flow aerodynamics Computational Fluid Dynamics (CFD), with High Performance Computing (HPC) enabling "zero-modelling assumption" Direct Numerical Simulations (DNS) on Trillions cells meshes. Current literature is awash with success stories on the related Large Eddy Simulation (LES) and Hybrid RANS-LES approaches where classic Re Averaged Navier Stokes (RANS) models bridge the small wall boundary layer, and these are already boasted in commercial CFD packages and even NPP circles (e.g. Nuclear Energy Agency Guidelines in CFD).

Carrying over this enthusiasm for fluid-wall heat transfer, central to NPP CFD applications, is premature for several reasons: The simplicity of LES modelling is at the expense of extensive CFD & turbulence expertise pre-requisites on the user side; Heat transfer is hugely affected by turbulence, unlike momentum where geometry and pressure-velocity is the main driver and turbulence secondary; many examples where the velocity-temperature (Reynolds) analogy breaks down and aerodynamics-originating models fail, particularly at walls (zero friction but maximum Nusselt number) will be shown. This unchecked over-confidence of CFD code developers and young practitioners is even more worrying when buoyancy is included, as present in accident scenarios or passive system. However incorporation of innovative, but little-reported RANS progress in near wall modeling, into Hybrid RANS LES methods for heat transfer is underway.

The presentation will alert CFD users against over-confidence in advanced CFD for NPP applications, but far from dowsing the current enthusiasm, we believe only few more years for robust implementation, coordinated validation, and user training are needed before the flawless "virtual wind-tunnel" extends to "the virtual NPP" experiment, at least at sub-component level.

Keywords: CFD, HPC, Heat Transfer

THERMOHYDRAULIC CODES ATHLET-CD AND COCOSYS

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GRS is a TSO which deals with technical-scientific research and provides expertise mainly for the regulatory authority. The field of activity includes also the development, validation and application of a large variety of simulation codes. The codes are intended to be used for the analysis of design basis and severe accidents for main different types of NPPs. The presentation contains a summary of the thermohydraulic codes ATHLET-CD and COCOSYS developed by GRS and applied for the simulation of reactor core/circuit respectively containment behaviour. Different methods applied for the coupling of additional codes modelling specific phenomena in an increased detail (3D codes) are shown. Finally several examples of the application of coupled codes are presented.

Keywords: Thermohydraulics code, coupling methods

SESSION 1.3

RADIATION TRANSPORT & ACCIDENT MODELLING

THURSDAY 10 DECEMBER 2015
14:00 - 15:30

CHAIR

S. Graham
National Nuclear Laboratory
UK

DIRECTIONS IN RADIATION TRANSPORT MODELLING

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Radiation transport modelling has been around for a long time, for instance the WIMS, MONK and MCBEND codes were in use in the UK nuclear industry in the 1960s, with applications in fields of reactor physics, criticality and shielding. Modelling has come a long way since those early days: whereas 2D simulation was the norm, 3D models are now common; multi-group energy schemes have been replaced by continuous energy nuclear data representations in Monte Carlo models; finer multi-group schemes have evolved for deterministic codes, with hundreds or thousands of energy groups; approximate geometries have been replaced by accurate 3D geometrical representations and can be imported from CAD files. More exciting advances are on the horizon to increase the power of simulation tools. The advent of high performance computers is allowing bigger, higher fidelity models to be created, if the challenges of parallelization and memory management can be met. 3D whole core modelling is becoming possible. Uncertainty quantification is improving with large benefits to be gained from more accurate, less pessimistic estimates uncertainty. Advanced graphical displays allow the user to assimilate and make sense of the vast amounts of data produced by modern modelling tools. Numerical solvers are being developed that use goal-based adaptivity to adjust the nodalisation of the system to provide the optimum scheme to achieve the user requested accuracy on the results, thus removing the need to perform costly convergence studies in space and angle etc. More use is being made of multi-physics methods in which radiation transport is coupled with other phenomena, such as thermal-hydraulics, structural response, fuel performance and/or chemistry in order to better understand their interplay in reactor cores. An overview is given of a range of current research topics which will provide an introduction to the remaining presentations in the radiation transport modelling session.

Keywords: Radiation Transport Codes, Monte Carlo Models

PREDICTIVE MULTI-PHYSICS MODELLING AND SIMULATION FOR NUCLEAR ENGINEERING

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Andrew Buchan, Imperial College London, UK

Computer models have played a central role in assessing the behaviour of nuclear power facilities for decades, they have ensured nuclear operations are efficient and remain safe to both the public and the environment. The focus of this talk is to present the most recent developments in the latest and highly advanced modelling capability being developed at Imperial College, namely FETCH2. This new multi-physics, predictive modelling framework is being formed to simulate coupled neutron transport, fluid flows and structural interaction problems. It combines novel and world leading technologies in numerical methods and high performance computing to form a simulation tool for geometrically complex, nuclear engineering problems that is both accurate and robust. One of the distinct capabilities of the model is the ability to extract maximum computational efficiency though self adaptive refinement of its mesh resolution, which works effectively across large computer platforms. This talk will demonstrate these capabilities by presenting various fluid flow and radiation simulations key to nuclear engineering – ranging from reactor physics, thermal hydraulics to severe accident prediction.

Keywords: Predictive modelling, FETCH2

DETAILED SEVERE NUCLEAR ACCIDENT MODELLING

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Dimitrios Pavlidis, Imperial College London, UK

Detailed numerical modelling of severe nuclear accidents is critical for improved reactor safety and increased accuracy of system codes. Progress on a consistent approach for thermal-hydraulic modelling of multi-phase and multi-material fluids with fluid-structure interactions and phase-change will be presented. The benefits of the proposed method will be demonstrated in wide range of accident scenarios. These include melting, relocation and solidification of fuel and control rods, melt pool behaviour and external coolability and debris bed coolability (boiling in porous media).

Keywords: Accidents, Direct Numerical Modelling

USE OF MASSIVELY PARALLEL COMPUTING TO IMPROVE MODELLING ACCURACY WITHIN THE NUCLEAR SECTOR

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Authors and Affiliations

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The extreme environments found within the nuclear sector will be even more demanding as future generation power-plants strive for further efficiency and increased output. It is required that components not only withstand such conditions but operate in their desired manner, thus large safety factors are imposed on modelling analyses. Improving analysis accuracy has clear value of increasing the design space which could lead to greater efficiency and reliability. Candidate novel materials for new reactor designs often exhibit non-linear behaviour, therefore are difficult to model accurately. Additionally, their material properties evolve through a combination of mechanisms such as fatigue and irradiation damage. To better describe these complex behaviours a range of modelling techniques previously under-pursued due to computational expense are being developed. With advancements parallel computing these analyses are now feasible. This work presents recent advancements in three techniques:

- Image based finite element modelling (IBFEM) directly converts three-dimensional images of components (e.g. X-ray tomography) into ultra-high resolution models with over a billion degrees of freedom to capture complex geometries and micro-features.
- Cellular automata finite element (CAFE) is a concurrent multi-scale approach; FE calculates engineering-scale strain fields whereas CA simulates damage in the material and stress fields at the meso-scale. The two-way transfer of information results in improved prediction of mechanisms such as brittle fracture.
- Uncertainty quantification (UQ) covers a broad range of approaches which aim to put measurable bounds on analysis results, yielding a better understanding of their weaknesses. Hence, further effort can be dedicated to increase confidence in modelling and lessen the requirement for generous safety margins.

Keywords: image based finite element modelling, random finite element modelling, cellular automata finite element, uncertainty quantification, high performance computing

SESSION 1.4

POSTERS

THURSDAY 10 DECEMBER 2015
16:00 - 17:30

MULTIPHYSICS BASED CONDITION MONITORING OF COMPOSITE MATERIALS

Corresponding Author

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H. Xue, P. Sharma, H. Khawaja, UIT The Arctic University of Norway, Tromsø, Norway

Composites are increasingly being used in products such as: automobiles, bridges, boats, drillships, offshore platforms, aircrafts and satellites. The increased usage of the composite materials and the fact that the conditions pertaining to their failure are not fully understood makes it imperative to develop condition monitoring systems for composite structures. In this work, we present a theoretical framework for the development of a condition monitoring system. For this, we plan to perform experimental and numerical analysis. The experimental analysis of composites will be carried out using a shock tube facility. The experimental data will be measured using sensors such as: strain gauges, thermocouples and pressure transducers. Furthermore, high speed camera and infrared thermography will be used for post processing of events. The numerical analysis will be carried out using ANSYS® Multiphysics software. The numerical simulation will be modelled using principles of Fluid-Structure Interaction (FSI), Finite Element Method (FEM) and Arbitrary Lagrangian Eulerian (ALE) methods. The proposed framework will allow us to identify the significant changes in composite structures leading to fault, failure or breakdown. The results will also shed light on factors such as maintenance scheduling, periodic inspection and lifespan analysis.

Keywords: Condition monitoring, Multiphysics, FEM, FSI, ALE, Composites

MULTIPHYSICS SIMULATION OF INFRARED SIGNATURE OF AN ICE CUBE

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This paper presents numerical methodologies to simulate the Infrared (IR) signature of an ice cube. The ice was frozen in a cold environment (-28oC) and allowed to have uniform temperature throughout. It was then taken out and let to warm at room temperature conditions by means of natural convection. A 3D transient heat equation is solved using three different methodologies. In the first attempt, the finite difference method is used to discretize the heat equation and solved using an FTCS (Forward-Time Central-Space) method in MATLAB® software. Then the same problem is modeled using the spectral method where the domain is discretized non-linearly for the appropriate solution. In the third attempt, the problem is modeled in ANSYS® Multiphysics software. The results obtained through all methodologies are found in close agreement. Also, the results reflect on the relation between IR imaging devices and the underlying physics of heat transfer.

Keywords: Infrared Signature, Ice, FTCS (Forward-Time Central-Space) Method, Spectral Method, ANSYS® Multiphysics, MATLAB®

REVIEW ON MARINE ICING AND ANTI / DE-ICING SYSTEMS

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Shipping operations are on the rise in the Arctic region. Due to these increased activities, maritime transport operations are encountering significant challenges with respect to the safety and reliability. These shipping operations are comprised of commercial vessels such as oil tankers, container ships, fishing vessels, tourism cruises, research and offshore exploration vessels and icebreakers. In this work, an effort is being made to review icing phenomenon in the marine operations. Two primary sources of icing are focused namely: atmospheric and sea spray. It is found from the literature that sea spray icing is the main contributor towards the marine icing. This work discusses the available ice accretion prediction models on a ship and offshore structures. This work also reviews the anti/de-icing technologies that can be implemented on ships for operations in cold climate region. The significance of ice detection is acknowledged, and a brief review of various ice detection technologies is discussed.

Keywords: Marine Icing, Ice accretion prediction models, Anti / De-icing Systems

MULTIPHYSICS INVESTIGATION OF ICE ADHESION OVER A PVC SURFACE

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This work investigates the ice over a PVC (polyvinyl chloride) surface as a two-layer laminate model. In this study, ice was frozen over a PVC surface and allowed to adhere. The built samples were tested experimentally in a four-point loading setup. The experimental results contain strain data gathered through data acquisition system using LabView® software. The data was collected at the rate of 1KHz per load step. This model is analysed theoretically using Euler–Bernoulli beam theory and the rule of mixtures. The correlations from Euler–Bernoulli beam theory and the rule of mixtures were coded in MATLAB® script for theoretical analysis. In addition, numerical simulations were performed using ANSYS® Multiphysics. The FEM model of ice and PVC sample was built using solid elements. The mesh was tested for its sensitivity. Finally theoretical results, experimental results and numerical simulation results were compared. A good agreement between the results was observed.

Keywords: PVC, Ice Adhesion, Euler–Bernoulli Beam Theory, Rule of Mixtures, LabView®, MATLAB®, FEM, ANSYS® Multiphysics

NUMERICAL APPROACH OF COUPLING VIBRATION MAGNETO-CONVECTION IN NANOFLUID

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The coupling vibration magneto-convection in nanofluid has importance in several areas such as the cooling of electronic systems, power generation, air conditioning, microelectronics. The objective of our work is to visualize numerically the effect of coupling vibratory excitation and magnetic field on cooling an electronic component or a solar cell (originality of our study) in arid and semi-arid area. A square cavity of side H filled with Al2O3-water nanofluid where an electronic component is placed on the bottom horizontal wall is maintained at isothermal hot temperature Th. The top horizontal wall is maintained at a cold temperature Tc. The vertical walls are adiabatic. The equations describing the natural convection flow in the square cavity consist of mass conservation, momentum and energy. For the physical parameters of Al2O3-water nanofluid, we use the Brinkman and Wasp model. Transport equations are solved numerically by finite element method. A numerical simulation of the problem was performed using the software Comsol Multiphysics. The results are obtained for Rayleigh numbers between 103 and 106, Hartmann numbers between 0 and 100 and vibratory excitation inclination angle between 0° and 90°. The external magnetic field inclination angle varies between 0° and 90°. Results are presented in the form of streamlines, isotherms, heat transfer flux ratio and maximum absolute value of stream function. The results lead to the following conclusions: The flux ratio and the maximum stream function decreases with increasing the vibratory excitation inclination angle. In the second half period promotes convection. Increase the horizontal position of the vibratory excitation promotes convective mode. The Hartmann number affects the values of the temperature, the stream function and the transfer mode. Increasing the Rayleigh number, the flux ratio and the maximum stream function increases. For proper cooling of electronic components or solar cell must be taken: a Hartmann number less than 30, an horizontal vibratory excitation and Rayleigh number greater.

Keywords: Coupling, Magneto-convection, Vibration, Nanofluid, Finite element

THE EFFECT OF IMPROVING THE OIL EXTRACTION OF SLOVENIA PRODUCTION SEED BY UNDERWATER SHOCK WAVE

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In National Institute of Technology, Okinawa College, the food processing device by the underwater shock wave has been developed. The effects of the improvement of the extraction, softening, sterilization, and emulsification, etc. by non-heating has achieved. On the other hand, the consumption of a variety seed oil is high in Europe. The improvement of the amount of the oil extraction from the seed leads to an increase in the agricultural output of Europe. In this study,the mechanism of the food processing device by underwater shock wave is explained. The device is composed of the water filtration device , the disintegrator (pressure vessel) and the power supply for shock wave generation. The seed is crushed by the underwater shock wave. Oil-bearing amounts of before and after crushing are compared. The ameliorating effect by the shock wave is shown.

Keywords: Underwater shock wave, Seed oil, Oil extraction, Food processing

MEASURING THE SEA SPRAY FLUX USING HIGH-SPEED CAMERA

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The sea spray contains water droplets that are produced due to sea waves that collide with the marine structures as well as the breaking of waves due to the strong winds. Similarly, fog and precipitation at sea level may contribute to the phenomenon of sea spray containing water droplets of minuscule sizes. Wind characteristics (speed and direction) also has a direct influence on the speed of water droplets as well their sizes. It has been found that sea spray flux is directly responsible for icing over marine structures, such as offshore oil rigs and ships. Therefore, it is of importance to devise a mechanism to measure sea spray flux with more accuracy. In this work, it is being proposed to capture sea spray flux using a high-speed camera. The study proposes a setup, which allows capturing the spray particles position at a given time. By capturing the images over time, and post processing in Image processing toolbox of MATLAB®, not only the speeds of particles can be determined but also variation in their sizes. This information can then be used to calculate the flux of water in the form of droplets per unit area. The setup will capture the instant value of sea spray flux, however, by repeating the experiment over time, the data can be averaged to estimate the sea spray flux in time. This setup may also be moved to various locations on the sea vessels or marine structures to build a comparison of locations subjected to higher or lower sea spray flux. The given information will reveal useful information regarding the design of marine structures especially, superstructure for ships for their effective operations in cold environments such as Arctic and Antarctic.

Keywords: Sea Spray, High-Speed Camera, MATLAB®, Icing, Marine Structures, Sea Vessels

ICE DETECTION EXPERIMENTATION SETUP USING INFRARED AND ACTIVE HEATING FOR MARINE OPERATIONS

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Considering the cold environment operations, ice accretion can occur at a rapid pace and can adversely affect the operations. In such scenario, ice detection is useful for the ice mitigation and removal upon the marine and offshore structures. Various techniques exist in the literature to detect the icing mainly utilizing its physical or electromagnetic properties. The parameters measured by these ice detectors includes its mass, rate and liquid water content. The work explains the possible implementation of Infrared (IR) ice detection technique. The experimentation setup is described keeping in view of the marine icing phenomena over the ships and offshore structures. The detection mechanism is unique from the passive IR detection by introducing the active heating concept underneath the observed surface. The intervention of the active heating information inside the IR ice detection system will able to improve the system's detection capability and disseminate the valid information at user interface level. The experimentation setup consists of various components operating at the various level of communication and shows strong cognitive capability contributing towards the outcome of valid ice detection.

Keywords: Ice Detection, Infrared, Active Heating, Marine Operations

FE-MODELL FOR CRITICAL LOAD ACCORDING THE SECOND ORDER THEORY OF ELASTICITY

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One of the most difficult challenges in structural stability is determining the critical load under which a structure collapses due to the loss of stability. The complexity of this phenomenon and the many material properties that are influenced by geometric and material imperfections and material nonlinearity. The idea is to propose a practical method for stability evaluation and critical load determination of structural elements. The stiffness matrix calculated according to second order theory of elasticity is used to show finite element model for critical load determination.

Keywords: Critical Load, Second Order Theory of Elasticity, Finite Element

OPTIMIZATION OF THE PERFORMANCE OF A BIOMEDICAL MICRO-PUMP

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The MEMS technology allow to improve the performance of the systems which use it, to increase their speed, their reliability and their potential of integration, but also to reduce their energy consumption and their dimension, this phenomenon of miniaturization allows to multiply the features integrated into the systems and to answer new needs in the biomedical industry such as the development of micro-pumps for various applications, and making possible parallel processing that leads to a production in large quantities at low cost. The development of the biomedical micro electromechanical system technology require a better understanding of fluid flows in micrometer scale, which gave birth to a new discipline called micro-fluidics. The use of polymeric materials such as PDMS(Polydimethylsiloxane) and PMMA(Poly methyl methacrylate) for the manifacture of microfluidic devices is a promising way made it possible to fabricate small size and high performance biomedical devices. The ppolymeric materials having particular physical and chemical properties, are good candidates for the development of new generation actuator. With greater complexity, shorter manufacturing, lower cost. They are much cheaper than silicon. Currently the technology related to PDMS and PMMA is the most widespread in the field of microfluidics. The PDMS finds its use in a wide range of microfluidic applications due to its flexibility and low cost. The PMMA attracts growing interest in microfluidics research community due to its low cost, high transparency, good mechanical and chemical properties. The objective of our study is to discuss in first steps the optimization of a micro-pump composed by deformable polymeric membrane in contact with reservoir and examine the effect of the materials property at the performance and the functionality of the system. The results of simulation by finite element are presented and discussed, in second steps is to study the power to inject by active membrane the fluid such as blood or glucose in microcanalization and precise the maximum value of flow rate at minimum applied pressure and control the fluid transportation. In conclusion this type of micropump appears to be suitable for biomedical applications and demonstrate the versatile use of active membrane as moving parts to inject the fluids.

Keywords: Micropump, Biomedical Devices, Membrane, PDMS, Finite Element

MAKING OF PRESSURE VESSEL FOR FOOD PROCESSING BY EXPLOSIVE FORMING

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Explosion forming is characteristic method. An underwater shock wave is generated by underwater explosion of explosive. A metal plate has high strain rate by this shock wave and is formed along a metal die. Although this method is advantaged mirroring with metal die shape, the free forming was used in this paper. An expensive metal die is not necessary for the free forming. It is possible that a metal plate is formed with simple supporting parts. However, the forming shape is depend on pressure distribution acted on the metal plate. This pressure distribution is able to change by explosive shape, mass of explosive and pressure vessel shape. On the other hand, we need a pressure vessel for food processing by underwater shock wave. Therefore, we propose making the pressure vessel by explosive forming for low cost making the pressure vessel. This pressure vessel will be a few made. One design suggestion of pressure vessel made of stainless steel was considered. The length, thickness, depth were 500mm, 8mm, 200mm respectively. The numerical simulation was carried out. Base of simulation method was ALE (Arbitrary Lagrangian Eulerian) method. Mie-Gruneisen EOS, JWL EOS, and Johnson-Cook Equation as material model were applied in this simulation. Underwater pressure distribution, forming process, deformation velocity of metal plate is discussed in this paper.

Keywords: Explosive Forming, Underwater Shock wave, High Strain Rate Forming

EFFECT OF A BI-MODAL DUST SIZE-DISTRIBUTION ON DUST-ACOUSTIC CNOIDAL WAVES

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The investigation of dust-acoustic solitons when ions are adiabatically heated, with both negative and positively charged dust grains with different sizes is conducted. An energy-like integral equation involving Sagdeev potential is derived. Under some physical conditions, the combined effects of the two populations of grains of different sizes and opposites charges, described by Dirac function (Bi-Modal dust size-distribution ie δ-distribution of two dust grain species withe radii rd1 and rd2) is found to provide the possibility for the transformation of the solitary solutions into cnoidal ones. The bi-modal dust size-distribution can significantly affect both lower and upper critical Mach numbers for both solitons and cnoidal solutions.

Keywords: Dusty Plasma, Dust-Acoustic Solitons, Bi-Modal Dust Size-Distribution, Cnoidal Solutions

MULTIPHYSICS BASED NUMERICAL STUDY OF ATMOSPHERIC ICE ACCRETION ON A FULL SCALE HORIZONTAL AXIS WIND TURBINE BLADE

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Atmospheric icing on wind turbines have been recognized as a hindrance to the development of the wind power in cold regions, where uncertainty surrounding the effect of icing on energy production may prevent otherwise good wind resources from being utilized. A variety of problems due to icing on wind turbines occur such as complete loss of power production, reduction of power due to disrupted aerodynamics, overloading due to delayed stall, increased fatigue of components due to imbalance in the ice load and damage or harm caused by the uncontrolled shedding of the large ice chunks. Experimental analyses of such issues are costly; therefore, in this research work, efforts is focused to numerically simulate and analyse the effects of both operating and geometric parameters on resultant rate and shape of ice accretion on a full-scale wind turbine blade. 3D computational fluid dynamics bases multiphase numerical modelling of ice accretion on the wind turbine blades is a complex coupled process that involves the airflow, droplet & surface thermodynamics. In this research work analyses have been carried out to understand the atmospheric ice growth on the wind turbine blade, which showed an increase in blade profile size reduces the atmospheric ice accretion at leading edge, both in terms of local mass and ice thickness. Results also show an increase in the ice growth with the increase of droplet size, whereas change in atmospheric temperature significantly affects the shape of accreted ice. Streamlined ice shapes were observed for low temperatures, whereas horn shape ice accretion was found at higher temperatures.

Keywords: Wind turbine, atmospheric icing, CFD, Droplets, Temperature

MULTIPHYSICS BASED DESIGN STUDY OF AN ATMOSPHERIC ICING SENSOR

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Design of a prototype modular atmospheric icing sensor with adequate potential to detect an icing event, icing type, icing load & icing rate has been initiated by the atmospheric icing research team of Narvik University College. This prototype of atmospheric icing sensor is based on hybrid technique by coupling rotational and capacitive physics, where rotational physics is used to measure icing load and icing rate and capacitive physics can be used to detect icing event, icing type and melting rate. The aim of this research paper is to discuss the design and development process of this prototype icing sensor, which involves coupling of various multi-physics tools and techniques. Multiphysics based analytical, numerical and experimental techniques has been used during the design and development process of this sensor, which will be discussed in this research work.

Keywords: Atmospheric icing, Sensor, Rotation, Capacitance, Multiphysics

SESSION 2.1

ADVANCED MODELLING TECHNIQUES

FRIDAY 11 DECEMBER 2015
10:00 – 11:00

CHAIR

A. Tehrani
Office for Nuclear Regulation
UK

A MULTI-PHYSICS APPROACH TOWARDS CHEMICAL PROCESS ENGINEERING WITH THE EXTENDED DISCRETE ELEMENT METHOD (XDEM)

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Process engineering covers a broad range of engineering applications from treatment of raw materials such as steel making to refinement of materials as employed in the pharmaceutical industry. Common to these applications is a solid as a particulate phase that undergoes various interactions with a fluid phase such as heat transfer or chemical conversion. Thus, a more than promising numerical technique is to represent these systems by a coupled Euler-Lagrange approach that resolves the particulate phase with the Discrete Element Method (DEM) and describes the fluid phase with classical methods of Computational Fluid Dynamics (CFD). In order to represent chemical conversion of particles, the classical DEM that predicts motion of particles in space is extended by thermodynamics for each particle. Solving one-dimensional and transient differential conservation equations yields the thermodynamic state e.g. temperature and species distribution including chemical reaction of each particle in a packed or moving bed. The arrangement of particles defines a void space between them, through which a gas or a liquid steams. This is described by CFD, which predicts the spatial and temporal fields for velocity, temperature and composition. Hence, the local conditions in the vicinity of each particle are also determined, that allows an accurate estimation for exchange of heat, mass and momentum between the fluid and the particles.Hence, the approach resolves the particle processes in conjunction with the prevailing flow field accurately so that the sum of all particle processes represents the integral behavior of the afore-mentioned processes. An analysis of predicted data obtained allows unveiling the underlying physics and subsequently an improved design or operating conditions.

Keywords: Euler-Lagrange coupling, DEM, CFD, chemical reaction engineering

OPENFOAM BASED MODELING OF 3D PARTICLE MOTION AND DEPOSITION WITHIN ELECTRO-STATIC FIELDS

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The quality of Electro-Static coating processes of metallic substrates is related to the uniformity of coating layer thickness. To increase that uniformity, knowledge based adaptions of process parameters and or geometry are required.

In order to create the basis of such knowledge based improvement efforts, this work presents a comprehensive, qualitatively verified, 3D modelling approach of the electro-, fluid-dynamic conditions in the vicinity of a coated substrate.

Local coating thickness is a function of coating particle imission density. Thus the model is based upon an implementation of the governing effects on coating particle motion and deposition within the coating chamber and on the substrate surface. It considers the effects of electro-static-, fluid-dynamic- and gravity forces, as well as particle shape effects and particle-particle interaction on coating particle motion and deposition. The model has been implemented within OpenFoam, is transient in nature with respect to the applied Lagrangian particle, immersed boundary methodology and stationary, regarding electro-static and fluid-dynamic phenomena. Qualitative verification of the developed solver has already been achieved and will hereby be presented alongside a thorough description of the model itself.

Keywords: OpenFoam, particle dynamics, coating, electro statics, fluid dynamics

MULTISCALE MODELING OF POLLUTANT UPTAKE BY MANGROVES

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Metal contaminants and organic pollutants are affecting aquatic environments in urban and industrial zones. Mangrove trees are capable of absorbing metal ions and organic pollutants like PCB and PAH. Located in tidal zones of river estuaries mangrove forests may function as a means for immobilization and removal of pollutants. Models are set up for the pollutant transport at the scale of single trees and at catchment scale. For single trees a three dimensional model of water and substance flow in the soil plant system based on porous media equations was developed which is based on cohesion-tension theory. Water transport in soil and tree is conceived as a continuous hydraulic process, which is driven by canopy transpiration. State variables are water potential and pollutant concentrations in the soil, roots, xylem, core and canopy. The model equations are obtained by application of Richards equations with. The water transport equations are coupled to the pollutant transport equations via the Darcy velocity and the dispersion tensor. Water evaporation from leaf mesophyll cells is taken into account by a biological transpiration sub model.

At catchment scale, the action of the mangrove forest is conceived as a flow reactor. The single plant model is replaced by an uspscaled model derived from the single plant model by fitting a compartment model in form of ordinary differential equations to model generated data. These equations are then imbedded into the shallow water equations for riverine transport, which are coupled to pollutant transport equations with reaction terms derived from the upscaled model. At both scales the models couple physical processes such as water and contaminant transport and biological processes such as transpiration and the fate of pollutants in the soil - plant system. The governing equations consist of a system of coupled non linear partial differential equations with reaction terms which were implemented into the finite element tool COMSOL MULTIPHYSICS based on the Petrov-Galerkin scheme. The model was applied to an estuary in Vietnam with mangroves under tidal influence.

Keywords: Pollutant transport,multiscale multiphysics modeling, shallow water flow, porous media

SESSION 2.2

IMPACT AND EXPLOSIONS

FRIDAY 11 DECEMBER 2015
11:30 – 13:00

CHAIR

B. Alzahabi
Kettering University
USA

A COMPUTATIONAL SIMULATION FOR SOIL SURFACE AND UNDERGROUND EXPLOSION -THE EFFECT OF DIFFERENT SOIL CHARACTERISTICS ON A FRAGMENTS BEHAVIOR-

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In order to clarify the fragments behavior such as shells, charges and soils, the computational simulation for soil surface and underground explosive problem has been constructed and performed using Smoothed Particle Hydrodynamics (SPH) schemes by HyperWorks-RADIOSS (®Altair) software. In this report, a study about the influence of the variability of the soil characteristics on the fragments behavior is performed. Results of computational simulations performed with different amounts of explosive on the soil surface and underground are presented. By conducting a series of computational simulations, it has been observed the fragments behavior depending on soil characteristics and amounts of explosive.

Keywords: Computational Simulation, SPH, Soil Characteristics, Fragment Behavior

DESIGN OF PRESSURE VESSEL FOR FOOD PROCESSING MACHINE BY UNDERWATER SHOCK WAVE

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In National Institute of Technology, Okinawa College, the food processing device by the underwater shock wave has been developed. The effects of the improvement of the extraction, softening, sterilization, and emulsification, etc. by non-heating are achieved. Therefore, a lot of foods are crushed by this mechanism, and has verified the effectiveness. In this presentation , we report on the design, production and analysis of pressure vessel of food processing device for a variety of food. The food processing device are composed of the circuit for the shock wave generation, the pressure vessel for crushing, the water clean device. Pressure vessel for crushing the food is designed to withstand the high pressure of the shock wave. Inside the pressure vessel, water is filled and, brass electrode of one set is fixed by the insulating resin. Silicone hose submerged in the interior of the pressure vessel, the vessel is sealed by a lid (flange) by a bolt and nut. Electric energy boosted to 3500V by the power supply is applied to the electrodes of the pressure vessel by the gap switches. The foods are crushed by the shock wave that is propagated through water and the silicone hose. The pressure-resistant of the pressure vessel is evaluated by the experimental crushing results of the food. The deformation amount of the container by the shock wave generation are shown using computer simulation.

Keywords: Underwater shock wave, pressure resistant vessel, Simulation, Food processing

AN OPTICAL OBSERVATION OF SHOCKWAVE PROPAGATION INDUCED BY UNDERWATER WIRE EXPLOSION

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To develop a robust food processing system, we have been investigating a shockwave propagation phenomena induced by underwater wire explosion. This system consists of a high voltage capacitor bank with gap switch, water tank and wire explosive part. We have carried out the optical observation with respect to the shockwave generated by a wire explosion using electric discharge in the water tank. Simultaneously, we have measured a shock pressure and have also investigated the effect of the various electrical characteristics on the shockwave propagation phenomena. In order to obtain the various strength of underwater shockwave, 0.6, 1.0 and 1.4 mm width wire made from aluminium plate of 1.0 mm thickness have been used at various voltages. As an example, the shock wave of 1600m/s propagation velocity was observed with 1.0mm width aluminium wire explosion. The detail will be reported at conference. We can see that the strength of shockwave has been well-controlled by the discharge voltage and various wire size.

Keywords: Wire explosion, underwater shockwave, optical observation

WATER FREEZING PHENOMENA BY DECOMPRESSION

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The latent heat of the evaporation for water is very big compared with other fluid. Therefore, when evaporation is promoted by decompressing, water lowers the temperature and freezes finally. We made them freeze without applying heat by decompressing water using a vacuum pump. Even if water caused boiling, the pressure kept falling, but when freezing finally, pressure build-up was measured. It was expected that pressure build-up is caused by increase of the evaporation amount by the latent heat release when freezing. An experiment was made in detail. This is the transition phenomenon when switching over from evaporation to sublimation. This seems to bring useful information when considering a phase change model.allocation.

Keywords: Water, Decompression, Freezing, Phase change

SESSION 2.3

AVIATION AND AUTOMOTIVE

(Sponsored by the Association of Aerospace Universities)

FRIDAY 11 DECEMBER 2015
14:00 – 15:30

CHAIR

G. Boiger
Zurich University of Applied Sciences
Switzerland

FATIGUE LIFE ESTIMATE OF HITCH CARGO BASKET USING MODEL ANALYSIS

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In this research, the ability of local market Sport Utility Vehicles' (SUV) hitch cargo baskets to withstand both static and dynamic loads are analyzed. At first, information for different types of hitch cargo baskets available in the local market and vehicles that could use these baskets are collected. Then, the actual parts of each hitch cargo basket are examined to identify the dimensions, the manufactured material, and the joints/connections of the parts. Then, a complex simulation program is used to carry out the analyses using the Finite Element Method (FEM), along with appropriate fatigue-life models. Knowing that the forces resulting from road surfaces have a direct effect on the lifespan of the basket's structure due to vehicular vibrations, an actual Power Spectrum Density (PSD) profile is calculated and algorithm is added in order to transfer the support's movement from the automobile to the basket structure. Finally, the critical sections of the hitch cargo basket are identified and the life time of the basket is estimated. Knowing that, different fatigue methods are used for the analysis of lifetime as it is proven to provide accurate results for large number of applications in the automotive industry.

Keywords: Fatigue, vibration, Hitch, Basket, Life time

GREEN'S INTEGRAL REPRESENTATION OF OSCILLATORY MOTION IN FLUIDS FOR MODELLING SWIMMING AND FLAPPING MOTIONS THAT GENERATE STEADY FORWARD PROPULSION

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We study oscillatory motions in fluids such as the swimming of small robots, self-propulsion of micro-organisms, Micro-Electro-Mechanical System (MEMS), acoustic devices and flapping objects. The resulting swimming or flapping motion generating a steady forward propulsive velocity can equivalently be considered as a problem of uniform flow past an oscillating body. Assume that the resulting far-field flow of the equivalent problem consists of both steady and time periodic components. The time periodic component is decomposed into a Fourier expansion series of time harmonic terms. The form of the steady term is given by the steady oseenlet and is well-known. However, the time-harmonic terms given by the oscillatory oseenlets are not known. We present these, which are the Green's functions in the oscillatory Oseen equation Green's integral representation. It is then shown that the force generated by the oscillatory oseenlet is itself oscillatory, yielding a key result that the net propulsive force originates from the steady oseenlet term only. Applications of this new representation are discussed. In particular, the swimming or flapping motion at low Reynolds number requiring a matching to a near-field Stokes flow. Further challenges for future work are outlined, for example the difficulty that the point forces are fixed rather than oscillatory which inhibits their use.

Keywords: Oscillatory motions, Oseenlets, flapping and swimming motions

HIGH-LIFT PERFORMANCE AND FLOW CONTROL FOR FLYING-WING UNMANNED AIR VEHICLE CONFIGURATIONS USING LEADING EDGE AND CROSS-FLOW SLOTS

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The current generation of Unmanned Combat Air Vehicle (UCAV) technology demonstrators employ flying-wing, edge-aligned configurations in order to reduce their radar cross section (RCS) characteristics. The resulting wing-sweep angles are non-optimal from an aerodynamic point of view for vehicles designed to cruise at high subsonic Mach numbers. The novelty of the current research is to investigate using leading-edge slots and cross-flow slots for passive flow-control. Researchers in the past have used several passive flow-control techniques, which include apex flap, barriers, slats and fences but such flow-control methods have an adverse effect on detectability characteristics of flying-wing configurations under investigation in this research. Therefore, the ultimate aim of the current research is to validate the experimental investigations with high fidelity numerical methods and to present and implement novel flow-control techniques such as leading-edge slot and cross-flow slot techniques.

In order to analyse the lift characteristics and flow control on representative UCAV configurations, it was deemed necessary to carry out experimental and numerical analysis on an uncontrolled baseline case before implementing a flow control mechanism on UCAV models under investigation. For this purpose, experimental and numerical investigations were carried out on two flat plate UCAV models. One of those two models has a sweep angle of 40 degrees and a root chord of 0.4m (Configuration 1). The other cranked UCAV model has a leading edge sweep of 60 degrees and a root chord of 0.53m (Configuration 2). The high-lift performance of the two configurations was measured in low-speed wind tunnel and compared with predictions using the Vortex Lattice Method (VLM), Euler and RANS methods, and these results will be presented together with conclusions on the effectiveness of using the leading edge and cross-flow slots.

Keywords: Flow Control, UCAV, Aerodynamic performance, Flying-Wings, High-Lift

A NEW METHODOLOGY FOR FUEL MASS COMPUTATION IN AN OPERATING AIRCRAFT

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The paper performs a new computational methodology for an accurate computation of fuel mass inside an aircraft wing during the flight. The computation is carried out using hydrodynamic equations, classically known as Navier-Stokes equations by the CFD community. For this purpose, a computational software is developed, the software computes the fuel mass inside the tank based on experimental data of pressure gages that are inserted in the fuel tank. Actually and for safety reasons, Optical fiber sensor for fluid level sensor detection is used. The optical system consists to an optically controlled acoustic transceiver system which measures the fuel level inside the each compartment of the fuel tank. The system computes fuel volume inside the tank and needs density to compute the total fuel mass. Using optical sensor technique, density measurement inside the tank is required. The method developed in the paper, requires pressure measurements in each tank compartment, the density is then computed based on pressure measurements and hydrostatic assumptions. The methodology is tested using a fuel tank provided by Airbus for time history refuelling process.

Keywords: CFD, Aircraft fuel Tank

SESSION 2.4

APPLICATIONS IN MULTIPHYSICS

FRIDAY 11 DECEMBER 2015
16:00 – 17:30

CHAIR

E Albahkali
King Saud University
KSA

A REVIEW OF THEORETICAL EFFICIENCY OF HIGH PRESSURE CO2 TRANSPORT

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Carbon Capture and Sequestration (CCS) is a key technology in global efforts to limit climate change. The elements required by CCS are often characterized as a chain consisting of three parts: capture, transport and storage. Although the capture part consumes the most energy and cost, the transportation of CO2 is also energy intensive and is, therefore, an important research focus.

A key element of the transportation infrastructure required for CCS projects will be CO2 compression. Since the majority of capture processes generate CO2 at low pressure and CO2 pipelines are likely to be operated well above the critical pressure of CO2 (7.39 MPa), a relatively complex, multi-stage, compressor design is required to meet the duty. There are also two important process alternatives: compression to supercritical conditions avoiding phase change & compression to intermediate pressure followed by liquefaction and pumping to high pressure. Although much research and development work has been conducted on both of these alternatives, little work can be found comparing these alternatives on a common basis.

The present research work examines the theoretical maximum efficiency of a variety of compression and pumping configurations based on the underlying thermodynamic principles. Compression power and the performance of various heat pump cycles is estimated based on a consistent set of assumptions. The overall theoretical minimum power consumption is calculated using MATLAB®. The results are then further developed using the Aspen HYSYS® process simulation software. Optimum configurations are identified which will form the subject of further study.

Keywords: Carbon Capture and Sequestration (CCS), Carbon dioxide, Liquefaction, Compression, MATLAB®, HYSYS®

EXPERIMENTAL AND NUMERICAL INVESTIGATION OF THE TAPPING OF A WINE GLASS

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The well-known sound of a knife or fork tapping on the side of a wine glass or goblet is widely used to gain the attention of a large gathering at weddings, banquets, and other social events. Using analysis of audio recordings, experimental modal analysis, and numerical modeling, the sound produced by this tapping can be understood in terms of the geometry and material properties of the bowl of the goblet. Radiation patterns created as the structural vibration couple into the surrounding medium also play a role in this familiar and attention-grabbing sound.

Keywords: Acoustics, Structural Vibration Acoustics

COMPARISON BETWEEN STATIC AND DYNAMIC VEHICLE STABILITY MODELS

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Despite the huge progress in automotive electronic stability and active safety systems, road-side accidents involving bad driving behaviors, rogue forces and un-safe road conditions continue to be one of the main causes for fatal accidents. Despite the various vehicular design changes that led across the 1990-2010 period to the lowering the centre of gravity of most vehicles to increase static stability, further development of onboard computer programs and road design protocols seems now to be the only way forward if these problems are to be further reduced now. Such an endeavor calls for the availability of better analyses models to automotive engineers/designers, onboard vehicular stability system programs, road engineers and the various national and international legislative authorities. Such models are broadly classified as either static or dynamic with most of the literature available concentrating on static models while the fewer newer dynamic models published seem to avoid providing their definitions of the various terms used in their calculations. This work attempts to study the various models shortcomings in addition to researching the safest models to safely use to predict rollover instances especially for Sport Utility Vehicles (SUV). These are particularly prone to such accidents and un-fortunately very popular in the Kingdom of Saudi Arabia.

Keywords: Rollover, Vehicle, SUV, Nonlinear model, Hitch, Basket, Real-Time, Static, Dynamic

A STUDY ON THE EFFECT OF ADDING HITCH CARGO BASKET TO SUVS' ROLLOVER USING REAL-TIME NONLINEAR MODEL

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Rollover accidents are one of the major risks facing today's vehicles. This is especially true for Sport Utility Vehicles (SUVs) nearly 40 percent of the total fatal crashes are attributed to SUV rollovers alone meaning that SUVs are much more likely to face a rollover situation in serious accidents. Therefore, in this study, a comprehensive verification of different SUVs propensities for rollover is being carried out that covers various static and dynamic assessment criteria. First, a closer look at different SUVs Static Stability Factor (SSF) is done in this study. Moreover, a nonlinear vehicle model using MatLab/Simulink is constructed to carry out a dynamic rollover situation using standard models published in the literature which consider various variables such as centre of gravity height, wheel base, track width, vehicle mass (sprung and un-sprung), moment of inertias, spring stiffness, ground friction and damping coefficient. The model is verified against measured results from NHTSA J-turn and Fishhook steering manoeuvres for calibration. Furthermore, this study looks at the effects of adding rear hitch cargo baskets on vehicle safety. The maximum speed, inertia and centre of gravity location effects are studied to assess the road stability of such vehicles and the maximum loads that could be transported safely.

Keywords: Rollover, Nonlinear model, Hitch, Basket, Real-Time

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