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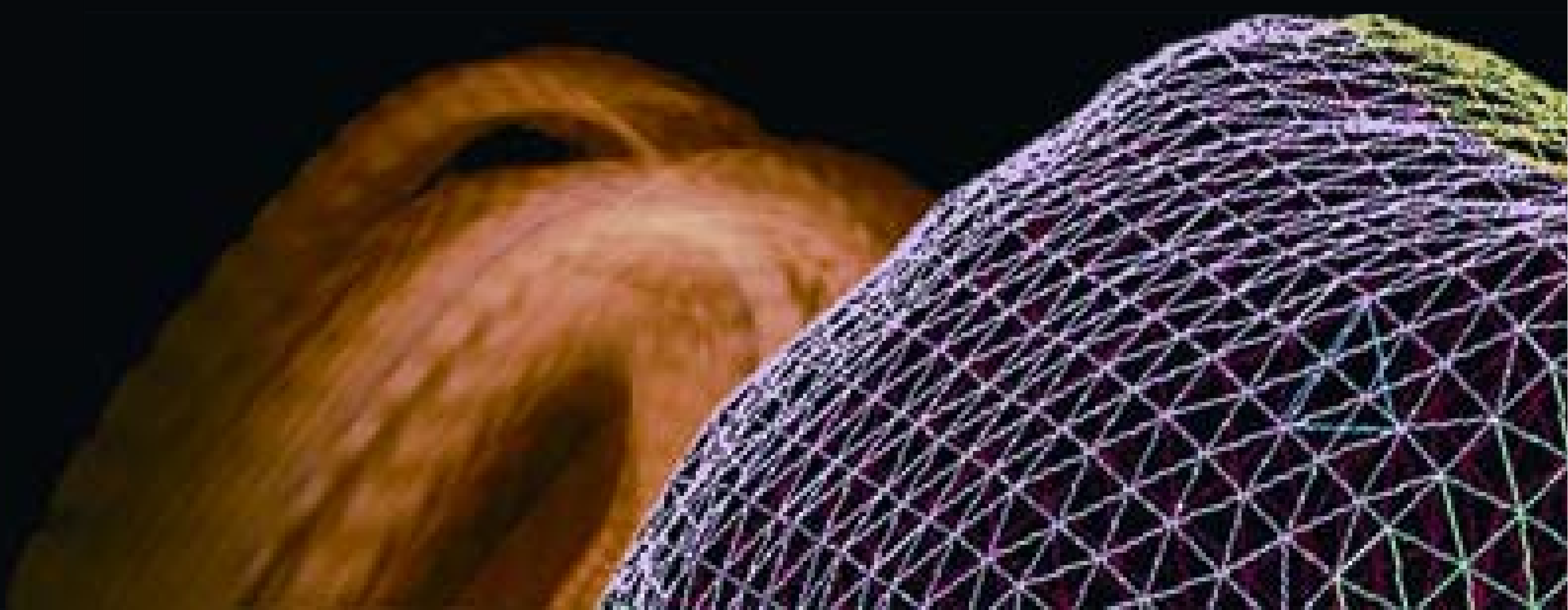
MULTIPHYSICS 2016

8 - 9 December 2016
Zurich, Switzerland



MULTIPHYSICS 2016

8-9 December 2016
Zürich, Switzerland

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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, 8th December	9:30-17:30
Friday, 9th December	9:30-17:30

Special Events

Thursday, 8th December 11:00
Group Photograph

Thursday, 8th December 19:30
Conference Banquette

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 are invited to submit full-length papers for publication in 'The International Journal of Multiphysics' by 31st January 2017.

There is no Article Processing Charge (APC) for one article per registration.

Sponsorship

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

Keynote Speaker

Prof. Dr. Henrik Nordborg
Institute of Energy Technology
HSR University of Applied Sciences
Switzerland

BIOGRAPHY

- 1986 – 1992 MSc in Engineering Physics from the ETHZ (Switzerland) and LTH (Sweden)
- 1993 – 1997 PhD in Theoretical Physics at the ETHZ Zürich. Topic of the thesis: Phenomenology of superconductivity
- 1997 – 2000 post-doc a at the Argonne National Laboratory and University of Chicago
- 2000 – 2008 ABB Corporate Research (scientist and team leader)
- 2008 – 2010 Multiphysics Consultant (ANSYS-CADFEM)
- 2010 – present Professor of Physics at the HSR University of Applied Sciences, Rapperswil, Switzerland
- Chairman of the NAFEMS Multiphysics Working Group

MULTIPHYSICS 2016

PROGRAMME

TIME	Thursday 8 December 2016	Friday 9 December 2016
09:30 - 10:00	**Registration**	
10:00 - 11:00	**Keynote Address**	**Session 2.1** *Impact and Explosions*
11:00 - 11:30	**Tea/Coffee Break**	
11:30 - 13:00	**Session 1.2** *Applications in Multiphysics*	**Session 2.2** *Electromagnetics*
13:00 - 14:00	**Lunch**	
14:00 - 15:30	**Session 1.3** *Micro and Nano Systems*	**Session 2.3** *Advanced Modelling Techniques*
15:30 - 16:00	**Tea/Coffee Break**	
16:00 - 17:30	**Session 1.4** *Posters*	**Session 2.4** *Industrial Case Studies*
19:30	**Banquette**	

Full Programme

Thursday 8 December 2016

09:30 – 10:00 Registration

10:00 – 10:15 Conference Opening

Opening of The 11th International Conference of Multiphysics 2016
Dean J. M. Piveteau, Zurich University of Applied Sciences, Switzerland

10:15 – 11:00 Session 1.1
Keynote Address

Chair: M Moatamedi, The International Society of Multiphysics

Simulation of Electrical Arc from the Point of View of Computational Physics: Time Scales, Length Scales, and Coupling

Prof. Dr. Henrik Nordborg, Institute of Energy Technology, HSR University of Applied Sciences, Rapperswil, Switzerland

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

Thursday 8 December 2016

11:30-13:00 Session 1.2
Applications in Multiphysics

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

Multiphysics in Biology: a General Framework for Dispersal of Populations and Genetic Information

Otto Richter
University of Technology Braunschweig, Germany

Interpretation of Experimental Results of a 100 kW Dual Fluidized Bed Gasifier by Process Simulation

J. Fuchs, F. Benedikt, S. Müller, J.C. Schmid, H. Hofbauer
TU Wien, Austria

An Estimate of Gas Cylinder's Life Time

Essam Al-Bahkali[1], Mhamed Souli[2], M. Elrayes[1], S. Parvez[1], M. Moatamedi[3]
[1]King Saud University, Saudi Arabia, [2]Université de Lille, France, [3]The Arctic University of Norway, Norway

Applications of Radiative Transfer Modelling in Atmospheric Physics

Kåre Edvardsen
UiT The Arctic University of Norway, Norway

13:00-14:00 Lunch

Thursday 8 December 2016

14:00-15:30 Session 1.3
Micro and Nano Systems

Chair: A S Fallah, Imperial College London, UK

Coupled Thermo-Mechanical Fields and Graphene Nanostrucures: A Multiphysics Approach

R.V.N. Melnik, S. Prabhakar
Wilfrid Laurier University, Canada

Simulation of Non-Newtonian Dispensing Behaviour of a Micro Valve in Pharmaceutical Applications

M. Boldrini[1], G.Boiger[1], B. Bonhoeffer[2], M. Juhnke[2]
[1]Zurich University of Applied Sciences, Switzerland, [2]Novartis Pharma AG, Switzerland

Competing Interactions, and Magnetization Dynamics in Doped Rare-earth Manganites Nanostructural System

Wiqar Hussain Shah
International Islamic University, Pakistan

Fluid Dynamical Study of MAS Systems Working at Ultra-low Temperatures

Nicoleta Herzog, Dirk Wilhelm, Alex Weber
Zurich University of Applied Sciences, Switzerland

15:30-16:00 Tea / Coffee Break

Thursday 8 December 2016

16:00-17:30 Session 1.4
Posters

Active Infrared Observation for Ice Detection in Anti/De-Icing Systems for Marine Applications in Arctic Region

T. Rashid, H. Khawaja, K. Edvardsen
UiT The Arctic University of Norway, Norway

Applying CFD in Manufacturing of Polymer Composite Reinforced with Shape Memory Alloy via Resin Transfer Molding Process

Stephane Katherine Barbosa Moura da Silva, Carlos José de Araújo, Tony Herbert Freire de Andrade, Antonio Gilson Barbosa de Lima
Federal University of Campina Grande, Brazil

Applying CFD in the Analysis of Heavy Oil/Water Separation Process via Hydrocyclone

Kelly Cristinne Leite Angelim, Antonio Gilson Barbosa de Lima, Josedite Saraiva de Souza, Sidclei Benevides da Conceição
Federal University of Campina Grande (UFCG), Brazil

Applying CFD in the Analysis of Heavy-Oil Transportation in Curved Pipes Using Core-Flow Technique

Sidclei Benevides da Conceição, Kelly Cristinne Leite Angelim, Tony Herbert Freire de Andrade, Severino Rodrigues de Farias Neto, Antonio Gilson Barbosa de Lima
Federal University of Campina Grande (UFCG), Brazil

Computational Fluid Dynamic Analysis of the Tesla Turbine

C. Strand, H. Eidesen, H. Khawaja
UiT The Arctic University of Norway, Norway

Computational Fluid Dynamic Analysis of the Tesla Valve

H. Eidesen, H. Khawaja
UiT The Arctic University of Norway, Norway

Detection of Red Dye in Diesel Oil Using UV-absorption and Silicon Photo Detector

Bindu Sara Varughese, University of Tromsø-The Arctic University of Norway, Norway

Development of an Optimization Routine for a Pure Component Cascade LNG Liquefaction Process

O. Eiksund, S. Jackson, E. Brodal, UiT The Arctic University of Norway, Norway

Improving Mechanical Grip of Tyres on Snow and Icy Road Surfaces using Finite Element Method

S. Ludvigsen, H. Khawaja, UiT The Arctic University of Norway, Norway

Multiphysics Modelling of Powder Coating Applications

S. Weilenmann, G. Boiger

Zurich University of Applied Sciences, Switzerland

Parametric Study of Steam Injection in Heavy Oil Reservoir: A Numerical Investigation

Balbina Raquel de Brito Correia[1,2], Marcos Allyson Felipe Rodrigues[1], Bárbara Cynthia Carnaúba dos Santos[2], Antonio Gilson Barbosa de Lima[2]

[1]Federal University of Rio Grande do Norte, [2]Federal University of Campina Grande

Review of Peltier and Resistive Heating Elements through Infrared Imaging

M. Taimur, T. Rashid, H. Khawaja

UiT The Arctic University of Norway, Norway

Simulation of Photoelectrochemical Impedance for Water Splitting Solar Cells

P. Cendula, J. O. Schumacher

Zurich University of Applied Sciences, Switzerland

Solution of Pure Scattering Radiation Transport Equation using Finite Difference Method

H. Khawaja

UiT The Arctic University of Norway, Norway

Study of Acoustics Properties of SK One Component Polyurethane and its Application in Arctic Marine Structures

H. Xue[1], H. Khawaja[1], M. Moatamedi[1], Z. Sun[2], M. Souli[3]

[1]UiT The Arctic University of Norway, Norway, [2]China Institute of Water Resources and Hydropower Research, China, [3]Lille University of Science and Technology, France

Study of Ice Adhesion Behavior of SK One Component Polyurethane

H. Xue[1], H. Khawaja[1], M. Moatamedi[1], Z. Sun[2]

[1]UiT The Arctic University of Norway, Norway, [2]China Institute of Water Resources and Hydropower Research, China

Study of Materials' Impact Properties for Arctic Marine Structures

H. Xue[1], H. Khawaja[1], M. Moatamedi[1], Z. Sun[2], Y. Kwon[3]

[1]UiT The Arctic University of Norway, Norway, [2]China Institute of Water Resources and Hydropower Research, China, [3]Naval Postgraduate School, USA

Thermal Properties of SK One Component Polyurethane Using Experiments and Multiphysics Simulations

T. Ahmad[1], H. Khawaja[1], M Moatamedi[1], Z Sun[2], N Linmei[3]

[1]UiT The Arctic University of Norway, Norway, [2]China Institute of Water Resources and Hydropower Research, China, [3]Centre for Sustainable Development and Innovation of Water Technology, Norway

Towards the Model Based Development of a Combined Wood- and Coal Gasification Reactor

C. Ritschard, T.Ott, G.Boiger

Zurich University of Applied Sciences, Switzerland

Waterflooding Process in an Irregularly Shaped Oil Reservoir: A Finite-Volume Approach

Balbina Raquel de Brito Correia[1], Bárbara Cynthia Carnaúba dos Santos[1], Antonio Gilson Barbosa de Lima[1], Brauner Gonçalves Coutinho[2]

[1]Federal University of Campina Grande, Brazil, [2]State University of Paraíba, Brazil

Waterflooding Study in Heavy Oil Reservoir with Complex Geometry: Influence of the Injected Water Rate and Wells Location

Balbina Raquel de Brito Correia[1], Bárbara Cynthia Carnaúba dos Santos[1], Antonio Gilson Barbosa de Lima[1], Brauner Gonçalves Coutinho[2]

[1]Federal University of Campina Grande, Brazil, [2]State University of Paraíba, Brazil

19:30 Conference Banquette

Friday 9 December 2016

10:00-11:00 Session 2.1
Impact and Explosions

Chair: E Albahkali, King Saud University, KSA

Computational Simulation of Rain-induced Damage in Wind Turbine Blades

B. Amirzadeh[1], N. Navadeh[2], A. Louhghalam[1], M. Raessi[1], R. Hewson[2], M. Tootkaboni[1], A. S. Fallah[2]
[1]UMass Dartmouth, USA, [2]Imperial College London, UK

Simulations of Particle Collisions in a Non-Newtonian Fluid

Henrik Nordborg, Matthias Pasquon, Boris Ouriev
HSR University of Applied Sciences, Switzerland

Computational Simulation of Soften of Food by Food Processing Machine Using Under Shock Wave

Ken Shimojima, Yoshikazu Higa, Hirofumi Iyama, Ryou Henzan, Toshiaki Watanabe, Shigeru Itoh
National Institute of Technology, Okinawa College, Japan

11:00-11:30 Tea / Coffee Break

Friday 9 December 2016

11:30 – 13:00 Session 2.2
Electromagnetics

Chair: K Shimojima, Okinawa College, Japan

Electrothermal Simulation of Large-area Semiconductor Devices

Christoph Kirsch[3], Stéphane Altazin[2], Roman Hiestand[2], Tilman Beierlein[3], Rolando Ferrini[1], Ton Offermans[1], Lieven Penninck[2], Beat Ruhstaller[2,3]

[1]CSEM SA, Switzerland, [2]Fluxim AG, Switzerland, [3]Zurich University of Applied Sciences, Switzerland

Coupled CFD Simulation of Back-travel Problem in High-Voltage Circuit Breaker Development

Xiangyang Ye, Mahesh Dhotre, Sami Kotilainen

ABB Switzerland Ltd., Switzerland

Towards Model Based Re-design of the Copper Electro-winning Process

D. Brunner, G. Boiger

Zurich University of Applied Sciences, Switzerland

Electrostatic Precipitators – Modeling and Analytical Verification Concept

Donato Rubinetti[1], Daniel A. Weiss[1], Walter Egli[2],

[1]University of Applied Sciences Northwestern Switzerland, [2]EGW Software Engineering. Switzerland

13:00-14:00 Lunch

Friday 9 December 2016

14:00-15:30 Session 2.3
Advanced Modelling Techniques

Chair: M Souli, Université de Lille, France

Multi-parameter Optimization Method for the Design of Porous Diaphragms Applied in PH-measurement

G. Boiger, T. Ott
Zurich University of Applied Sciences, Switzerland

Developed Numerical Approach of The Melt-Crystals Phase-Changing Kinetics in Solidification Process

Yasser Safa, Thomas Hocker
Zurich University of Applied Sciences, Switzerland

On Frequency Band Structure in Anisotropic Phononic K3-metamaterials

V. N. Gorshkov[1], N. Navadeh[2], M. Tootkaboni[3], A. S. Fallah[2]
[1]Los Alamos National Laboratory, USA, [2]Imperial College London, UK, [3]UMass Dartmouth, USA

Acoustic Streaming – Numerical Modeling and Validation Concept for Acoustic Streaming induced by Ultrasonic Treatment

Donato Rubinetti, Daniel A. Weiss, Jonas Müller, Arne Wahlen
University of Applied Sciences, Northwestern Switzerland

15:30-16:00 Tea / Coffee Break

Friday 9 December 2016

16:00-17:00 Session 2.4
Industrial Case Studies

Chair: T Rahulan, University of Salford, UK

A thermo-, Fluid-dynamic Model of Transient Heat Distribution within Perfused Human Skin

T. Ott, G. Boiger, M.Bonmarin
Zurich University of Applied Sciences, Switzerland

SPH and FEM Formulations for Soil Structure Explosive Detonation

M. Souli[1], E. Al-Bahkali[2], I. Sharhrour[1], M. Moatamedi[3]
[1]Université de Lille, France, [2]King Saud University, Saudi Arabia, [3]The Arctic University of Norway, Norway

Path from Multiphysics-theory to Spin Off

Nils Reinke, Winterthur Instruments, AG, Switzerland

17:00 Close of Conference

17:00-18:00 Winterthur City Tour
From historical heavy industry to modern academia

SESSION 1.1

KEYNOTE ADDRESS

THURSDAY, 8 DECEMBER 2016
10:00 – 11:00

CHAIR

M Moatamedi
The International Society of Multiphysics

<u>Thursday, 8 December 2016</u>
10:00 – 11:00

Keynote Address

Simulation of Electrical Arc from the Point of View of Computational Physics: Time Scales, Length Scales, and Coupling

Prof. Dr. Henrik Nordborg
Institute of Energy Technology
HSR University of Applied Sciences
Switzerland

The electrical arc (or thermal plasma) has a surprisingly large number of technical applications. It is used to interrupt electrical currents in switchgear, to melt metals in arc furnaces and in welding applications, and to deposit material on a surface in plasma spraying applications. If we also consider non-thermal plasmas, the number of applications increases even further, ranging from medical to space technology.

The simulations of electrical arcs and other forms of industrial plasmas is very challenging for many reasons. It makes sense to divide the problems into two parts: 1. Numerical implementation and 2. Physical modeling.

It turns out that these two challenges are very closely linked due to the complexity of the physical problem, making it impossible to develop the models starting from first principles. Rather, a large number of numerical experiments and validation studies will have to be performed. This task is not possible without an efficient and numerically stable code. In other word, we are faced with the task of developing a simulation tool without knowing which models are required or whether the effort will eventually be successful.

Fortunately, the situation is not quite as bad as it sounds and it is more or less clear from basic physical considerations what model needs to be used. If we start with a thermal plasma at atmospheric pressure, it can essentially be modelled using the continuum equations for a conducting fluid coupled to the electromagnetic fields. The continuum approach is valid due to the fact that we are dealing with a collision dominated quasi-neutral plasma with a mean free path much shorter than relevant length scales. Furthermore, as the relevant time scales are not too short, we do not have to solve the full Maxwell but can safely ignore the displacement current.

Numerically, already this simplest model poses a significant modelling challenge. To begin with, the fluid dynamics problem represents a highly compressible turbulent flow with real gas properties and very high temperatures. It can only be solved using a finite volume solver with a good mesh and short time steps. Unfortunately, the best way to solve the Maxwell equations is to use a finite element method with higher order elements on a much coarser mesh. We are therefore forced to couple two solvers using different numerical schemes and different meshes. The natural approach – to use the flow mesh for the Maxwell solver – currently does not work very well as the Maxwell solvers lack the required scalability. An ideal solution would require a reformulation of the Maxwell problem and we present some ideas for this.

The next problem has to do with the material properties of the plasma and radiation transport. Using the approximation of local thermal equilibrium, the material data can essentially be pre-computed and stored in lookup tables. The only problem with this approach is that the tables grow very large when many species are involved. Furthermore, the plasma must be treated as an absorbing medium for radiation. Since the absorption properties are strongly frequency dependent, some very rough approximations are required to be able to handle the data. Finally, after having solved all these problem, we are still left with the topic of turbulence modeling.

It turns out that there are more modeling issues to be solved when simulating an electric arc. Perhaps most importantly, the arc interacts very strongly with the electrodes at the arc roots. The flow of electric current and the high temperature lead to significant erosion of the electrodes, producing significant quantities of metal vapor in the plasma. The physics at the surface of the electrode cannot be spatially resolved but must be included using effective models, incorporating the proper sources and voltage drop.

The Institute for Energy Technology has started a major research activity for implementing an industrial-grade simulation tools for thermal plasmas, which will later be extended to include non-equilibrium effects. The tool is based on the commercial flow solver Star CCM+ from CD-Adapaco, which has recently been extended to include an electromagnetic solver. The presentation will give an overview of scientific formulation of the problem, the numerical methods used, the required material models, and the experiments required to validate the tool.

SESSION 1.2

APPLICATIONS IN MULTIPHYSICS

THURSDAY 8 DECEMBER 2016
11:30 – 13:00

CHAIR

G Boiger
Zurich University of Applied Sciences
Switzerland

MULTIPHYSICS IN BIOLOGY: A GENERAL FRAMEWORK FOR DISPERSAL OF POPULATIONS AND GENETIC INFORMATION

Otto Richter
University of Technology Braunschweig, Germany

Dispersal of populations and genetic information involves both physical and biological processes. In the case of high population sizes such as mosquito populations the spatio-temporal dynamics can be described by systems of nonlinear reaction diffusion equations. The reaction terms model population- dynamics and genetics and the interaction between species. The space operator captures typical biological dispersal modes such as random diffusion or the active migration along gradients of environmental signals. As an example, the migration of plant parasitic nematodes in soils along a gradient of root exudates is considered. For the life cycle of species comprising mobile and immobile stages, systems of partial and ordinary differential equations are set up for the mobile and immobile stages respectively. Examples are plants with pollen and seeds and larvae of mosquitoes and their winged forms. This general model framework is applied to two relevant problems associated with dispersal. i) The invasion of alien species. Due to human migration and climate change invasion of alien species has been observed in Europe. Recently, the mosquito Aedes albopictus causing vector borne diseases has invaded the south of France. The spatial-temporal dynamics of invasion is studied in dependence of temperature and predation pressure of the resident ecosystem. ii) Emergence and dispersal of pesticide resistance. According to the number of loci, which code resistance, a large number of biotypes with different resistance factors and their genetic interactions are implemented into the model, e.g. for 3 gene loci, 27 biotypes have to be considered. Landscape structures are implemented into a finite element tool and the resulting initial boundary value problems involving systems of partial differential equations are solved by a Galerkin scheme. The system displays a richness of dynamic patterns such as travelling waves and hysteresis effects, which are assessed both by analytical investigations of the equations and simulations.

Gene flow Travelling waves, Dispersal Population genetics

INTERPRETATION OF EXPERIMENTAL RESULTS OF A 100 KW DUAL FLUIDIZED BED GASIFIER BY PROCESS SIMULATION

J. Fuchs, F. Benedikt, S. Müller, J.C. Schmid, H. Hofbauer
TU Wien, Austria

Dual fluidized bed steam gasification has long been subject of investigation at TU Wien. Based on this technology several industrial sized plants have been built (e.g. Güssing/AT, Oberwart/AT, Senden Neu-Ulm/DE). A steam operated gasification reactor and an air operated combustion reactor are the main parts and ensure the production of a nitrogen free product gas from different solid fuel types. The combustion reactor provides the necessary heat for the overall endothermic steam gasification via combustion of residual char from gasification. The produced heat is transported into the gasification reactor via a so called bed material, which is typical for fluidized beds. Usually silica sand or olivine is used for conventional gasification applications as bed material. By the usage of limestone as bed material and low gasification temperatures at about 650 °C combined with combustion temperatures above 800 °C the selective removal of CO2 from the gasification reactor is enabled. This leads to an equilibrium shift of the product gas composition towards high H2 contents because of the dominant water-gas-shift reaction. In October 2015 an experimental campaign was carried out by the use of an advanced 100 kWth test plant at TU Wien aiming at the investigation of different fuel types. All experiments were accompanied by mass and energy balance calculations conducted with the process simulation software IPSEpro. A comprehensive model library for biomass gasification has been developed to support the ongoing process development at TU Wien. The application oriented process simulation has been shown to be an important tool at TU Wien for the validation of measured data and for the calculation of performance indicating key figures such as water conversion rate, CO2 transport of circulating bed material, and many more. Therefore, process simulation is an essential tool for the application oriented process development as well as the scientific investigation of experimental phenomena. This way, simulation results provide crucial information for scale-up steps of the dual fluidized bed steam gasification process to industrial scale.

Acknowledgement: The present work is part of the research project ERBA II in cooperation with voestalpine Stahl GmbH and voestalpine Stahl Donawitz GmbH. ERBA II receives financial support by the research program “Energieforschung” funded by the “Austrian Climate and Energy Fund”.

Gasification, process simulation, Sorption enhanced reforming, SER, IPSEpro, Dual fluidized bed

AN ESTIMATE OF GAS CYLINDER'S LIFE TIME

Essam Al-Bahkali[1], Mhamed Souli[2], M. Elrayes[1], S. Parvez[1], M. Moatamedi[3]
[1]King Saud University, Saudi Arabia, [2]Université de Lille, France, [3]The Arctic University of Norway, Norway

In this research, the lifespan of gas cylinders used in homes is estimated. To complete the study comprehensively, both experimental and theoretical analysis is included. On the experimental side, several gas cylinders of different service lives is taken from the market to conduct the basic tests. These tests are visual inspection, pressure testing, and extracting some samples from the selected cylinders to carry out tensile, micro-hardness, fatigue and microstructural testing. On the theoretical side, simulations for cylinders with various service lives will be done to calculate its lifespan. Then, both experimental and theoretical analysis is compared to draw the conclusion for determining the expected service life at which gas cylinder is supposed to be retired from service.

Gas Cylinder, Life time, Fatigue

APPLICATIONS OF RADIATIVE TRANSFER MODELLING IN ATMOSPHERIC PHYSICS

Kåre Edvardsen
UiT The Arctic University of Norway, Norway

Ultraviolet (UV) and visible solar radiation are both important force factors with respect to meteorology, atmospheric chemistry, oceanography and biology. From a meteorological point of view, it is important to have knowledge about how changes in the radiative force factors like clouds, aerosols and albedo affects the photochemical and radiation balance in arctic regions in the long term. The increased atmospheric pollutants from human activity in the urban areas of the world have been trapped in the troposphere and changed the natural photochemical balance. This has resulted in phenomena like atmospheric ozone depletion in the arctic areas, and increase of toxic ground level ozone, and nitrogen oxides (NOx) in urban areas. These are well known phenomena, but little is known about the long term global effects of changes in the radiative force factors like clouds and ground albedo. Norwegian Institute for Air Research (NILU) set up an instrument at the Troll Research station in Antarctica (72□S, 2.5□E) in 2007 for continuous irradiance measurements of both UV and visible solar radiation. It measures UV-irradiance at five different wavelengths (305 nm, 312 nm, 320 nm, 340 nm, 380 nm) and integrated photosynthetically active radiation (PAR, 400-650 nm) every minute. By feeding the optical characteristics of the instrument into the radiative transfer model (libRadTran) it is possible to simulate what the data from the instrument should be with respect to the various radiative force factors. This manuscript describes how solar radiative transfer modeling of is used as a tool for estimation of several important radiative parameters like erythema UV-dose, total ozone column, PAR, cloud optical density. Some results from the Troll station have shown that during extreme ozone depletion events, the measured UV-dose is comparable with levels measured at the equator (Kampala, Uganda).

Atmospheric physics, UV-radiation, Ozone, Albedo, Radiative Transfer Modelling

SESSION 1.3

MICRO AND NANO SYSTEMS

THURSDAY 8 DECEMBER 2016
14:00 - 15:30

CHAIR

A S Fallah
Imperial College London
UK

COUPLED THERMO-MECHANICAL FIELDS AND GRAPHENE NANOSTRUCURES: A MULTIPHYSICS APPROACH

R.V.N. Melnik, S. Prabhakar
Wilfrid Laurier University, Canada

In this contribution we report our recently developed multiphysics approach to the study of several important effects in graphene nanostructures. It is well known that ripples are a typical feature of graphene sheets and thin films comprised of graphene membranes. They are produced by long wavelength corrugations and may greatly affect electronic properties of graphene-based systems and devices. Several mechanisms of inducing such ripples in graphene have already been discussed in the literature. Among them is electron-induced rippling in graphene, as well as elasticity-induced rippling, that may, in the general case, include nonlinear effects. The origin of graphene rippling continues to be debated. In the meantime, there is substantial experimental evidence that in order to control such ripples, a pure elasticity-based picture may not be sufficient and thermal properties of graphene may also be essential. Here, we illustrate how to develop and apply a fully coupled multiphysics model that describes thermomechanical processes in graphene sheets. Based on this model, we demonstrate that coupling between mechanical and thermal fields is an important factor in better understanding of the appearance of ripples in graphene. Next, we use a generalization of our multiband model to analyze the effects of such thermo-mechanically-induced ripples on the electronic properties of graphene. Results of computational experiments are shown for different boundary conditions that allow controlling ripples.

Multiphysics models for nanscience applications, Coupled thermo-mechanical effects, Graphene, Electronic properties, Band structure

SIMULATION OF NON-NEWTONIAN DISPENSING BEHAVIOUR OF A MICRO VALVE IN PHARMACEUTICAL APPLICATIONS

M. Boldrini[1], G.Boiger[1], B. Bonhoeffer[2], M. Juhnke[2]
[1]Zurich University of Applied Sciences, Switzerland, [2]Novartis Pharma AG, Switzerland

A piezo-actuated micro-valve is investigated for the dispensing of colloidal drug suspensions in the nano- and microliter range to manufacture drug products with individual adjustable dose strength. The experimental measurement and characterization of the dispensing process is relatively complex and time-consuming since the colloidal drug suspensions show a distinct Non-Newtonian flow behaviour. To support measurement based characterization efforts, two numerical fluid- dynamic models, which simulate different aspects of the dispensing process were developed using OpenFoam®. The quantitative model focuses on the prediction of the amount of dispensed fluid while the qualitative model resolves the behaviour of the fluid after ejection from the nozzle of micro valve. The quantitative model has been validated by comparing simulated- and experimentally determined dispensed amounts of five different colloidal drug suspensions at four different working pressure settings. The simulated results show good correspondence to experimental data with a discrepancy of no more than 15% in any of the cases. A validation of the qualitative model was performed by comparing simulation results with high speed camera recordings of the dispensing process. The main focus was set on distinguishing between different flow characteristics of the fluid after ejection from the micro valve, e.g. dripping, stable jet or unstable jet regimes.

Non- Newtonian, Dispensing, OpenFoam, Nano-liters, Droplets

COMPETING INTERACTIONS, AND MAGNETIZATION DYNAMICS IN DOPED RARE-EARTH MANGANITES NANOSTRUCTURAL SYSTEM

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The Structural, magnetic and transport behavior of La1-xCaxMnO3+ (x=0.48, 0.50, 0.52 and 0.55 and =0.015) compositions close to charge ordering, was studied through XRD, resistivity, DC magnetization and AC susceptibility measurements. With time and thermal cycling (T<300 K) there is an irreversible transformation of the low-temperature phase from a partially ferromagnetic and metallic to one that is less ferromagnetic and highly resistive. For instance, an increase of resistivity can be observed by thermal cycling, where no effect is obtained for lower Ca concentration. The time changes in the magnetization are logarithmic in general and activation energies are consistent with those expected for electron transfer between Mn ions. The data suggest that oxygen non-stoichiometry results in mechanical strains in this two-phase system, leading to the development of irreversible metastable states, which relax towards the more stable charge-ordered and antiferromagnetic microdomains at the nano-meter size. This behavior is interpreted in terms of strains induced charge localization at the interface between FM/AFM domains in the antiferromagnetic matrix. Charge, orbital ordering and phase separation play a prominent role in the appearance of such properties, since they can be modified in a spectacular manner by external factor, making the different physical properties metastable. Here we describe two factors that deeply modify those properties, viz. the doping concentration and the thermal cycling. The metastable state is recovered by the high temperature annealing. We also measure the magnetic relaxation in the metastable state and also the revival of the metastable state (in a relaxed sample) due to high temperature (800) thermal treatment.

Interaction, Nanostructure, Magnetization

FLUID DYNAMICAL STUDY OF MAS SYSTEMS WORKING AT ULTRA-LOW TEMPERATURES

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Solid chemical and biological probes are analyzed in Nuclear Magnetic Resonance (NMR) spectroscopy devices by means of the Magic Angle Spinning (MAS) method. This is a special NMR technique in which the MAS rotor containing the sample is rotated with very high frequencies in a magnetic field. For MAS rotors of e.g. 0.7mm diameter the spinning rate can reach 120 kHz. The rotation is realized through a Pelton type micro turbine that is mounted on the top end of the rotor. As driving fluid compressed gas is used, this is jetted out through duct nozzles aligned on an intake spiral. Up to now the micro turbine impellent with pressurized air at ambient temperature, is quite good investigated and designed. However, the turbine drive with gases at ultra-low temperatures was found to improve the resulting spectral signal by leading to a significant reduction of the spectral linewidth. Thus, the aim of the present study is the design and efficiency optimization of the micro-turbine driving with Helium at 40K and Nitrogen at 100K. For that CFD simulations were carried out and the results were compared with experimental measurements.

Numerical simulation, Micro turbine, Ultra low temperature, Nuclear Magnetic Resonance

SESSION 1.4

POSTERS

THURSDAY 8 DECEMBER 2016
16:00 - 17:30

ACTIVE INFRARED OBSERVATION FOR ICE DETECTION IN ANTI/DE-ICING SYSTEMS FOR MARINE APPLICATIONS IN ARCTIC REGION

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The number of shipping operations is on the rise in the Arctic region. As a result of these increased activities, significant challenges are being encountered with respect to safety and reliability. One of the challenges is an accretion of ice. Icing on ships and offshore structures is caused by atmospheric sources and sea spray. Sea spray is the main source of icing and is generated by wave collisions, breaking of waves due to strong winds, and bursting bubbles that float upon the waves. Heavy ice accretion poses a threat to the stability of ships and offshore structures by shifting their center of gravity. This study proposes an active infrared (IR) observation method for the detection of ice. This method is essential for automating anti/ de-icing systems, particular in marine applications. There are a number of challenges to overcome before the successful deployment of such a system including: the adequate protection of the equipment and the electronic devices from the environment; ensuring proper functioning of electronic devices below 0°C; synchronization of the IR image acquisition and processing / analysis; and optimization of the on/off timings of heating elements. The study focuses on identifying these technical issues and finding their appropriate remedies.

Ice Detection, Infrared Image, Automation, Cold Climate, Marine

APLLYING CFD IN MANUFACTURING OF POLYMER COMPOSITE REINFORCED WITH SHAPE MEMORY ALLOY VIA RESIN TRANSFER MOLDING PROCESS

Stephane Katherine Barbosa Moura da Silva, Carlos José de Araújo, Tony Herbert Freire de Andrade, Antonio Gilson Barbosa de Lima
Federal University of Campina Grande, Brazil

Automotive and aeronautics industries have turned increasingly to the development of materials that combine good mechanical properties and low density, in order to improve the performance of their products, giving them new applicability. In this context, more and more studies in the field of composite materials have been made, because of its extensive applicability and combination of properties. Composite can be defined as any multiphase material that exhibits a significant proportion of the two phases that constitute it, such that a better combination of properties is obtained. They consist generally of a continuous phase called matrix and a discontinuous phase, the reinforcement. Shape memory alloys, have gained visibility due to its properties of the phase transformation which occurs in the alloy. They are special metallic materials which possess the surprising ability of recover a plastic deformation or "elastic apparently" through a subsequent heating above a critical temperature. Polymer composites reinforced with NiTi alloy (shape memory alloy) have been applied in many industrial sectors. In this context, this paper aims to study the manufacturing process of polymer composite reinforced with shape memory metal alloys by RTM process using ANSYS CFX® software. The mathematical modeling consists of mass and momentum conservation equations applied to a metal mold with dimensions $0.3 \times 0.3 \times 0.002$ m^3 containing ten NiTi alloy wires 0.0005 m diameter. Results of the flow front position of the resin (polyester resin mixed with calcium carbonate particles), pressure, streamlines and resin velocity fields during the process are presented and discussed. We conclude that the addition of calcium carbonate resulted in increased resin viscosity and greater inlet pressure obtained at the entrance of the mold which resulted in short time to full fill the mold.

Polymer composites, Calcium carbonate, Shape memory alloys, RTM, CFD

APPLYING CFD IN THE ANALYSIS OF HEAVY OIL/WATER SEPARATION PROCESS VIA HYDROCYCLONE

Kelly Cristinne Leite Angelim, Antonio Gilson Barbosa de Lima, Josedite Saraiva de Souza, Sidclei Benevides da Conceição
Federal University of Campina Grande (UFCG), Brazil

In recent years most of the oil reserves discovered has been related to heavy oil reservoirs whose reserves are abundant but still show operational difficulties. This fact provoked great interest of the petroleum companies in developing new technologies for increasing the heavy oil production. The oil industry involves various segments that can attack the environment. Produced water generation, effluent recovered from the production wells together with oil and natural gas, is among the greatest potential factors for environmental degradation, depending on where it is discarded. Thus, a new scenario of the oil industry appears requiring improvement in treatment units for produced water. Among the technological improvements in the facilities, the use of hydrocyclones has been applied in the treatment of the oily water. Because the simplicity of construction, application versatility and compact size, the hydrocyclones seek to promote improvements in the quality of oil / water separation in order to meet environmental requirements. In this sense, this study aims to investigate numerically the separation process of heavy oil from a water stream via hydrocyclone, using the computational fluid dynamics technique. In the mathematical modeling was considered a two-phase, three-dimensional, stationary, isothermal and turbulent flow. Results of streamlines, pressure and volume fraction fields of the involved phases (oil and water) into the hydrocyclone and process mechanical efficiency and pumping power of the fluids are shown and analyzed. In conclusion, it seems that with increasing fluid input velocity in the hydrocyclone there is an increase in pressure drop, indicating a greater pumping energy consumption of the mixture, and greatly influences the separation process efficiency.

Heavy Oil, Hydrocyclone, Energy Efficiency, CFD

APPLYING CFD IN THE ANALYSIS OF HEAVY-OIL TRANSPORTATION IN CURVED PIPES USING CORE-FLOW TECHNIQUE

Sidclei Benevides da Conceição, Kelly Cristinne Leite Angelim, Tony Herbert Freire de Andrade, Severino Rodrigues de Farias Neto, Antonio Gilson Barbosa de Lima
Federal University of Campina Grande (UFCG), Brazil

Multiphase flow of oil, gas and water occurs in the petroleum industry from the reservoir to the processing units. The occurrence of heavy oils in the world is increasing significantly and points to the need for greater investment in the reservoirs exploitation and, consequently, to the development of new technologies for the production and transport of this oil. Therefore, it is interesting improve techniques to ensure an increase in energy efficiency in the transport of this oil. The core-flow technique is one of the most advantageous methods of lifting and transporting of oil. The core-flow technique does not alter the oil viscosity, but change the flow pattern and thus, reducing friction during heavy oil transportation. This flow pattern is characterized by a fine water pellicle that is formed close to the inner wall of the pipe, aging as lubricant of the oil flowing in the core of the pipe. In this sense, the objective of this paper is to study the isothermal flow of heavy oil in curved pipelines, employing the core-flow technique. A three-dimensional, transient and isothermal mathematical model that considers the mixture and turbulence models to address the gas-water-heavy oil three-phase flow in the pipe was applied for analysis. Simulations with different flow patterns of the involved phases (oil-gas-water) has been done, in order to optimize the transport of heavy oils. Results of pressure and volumetric fraction distribution of the involved phases are presented and analyzed. It was verified that the oil core lubricated by a fine water layer flowing in the pipe considerably decreases pressure drop.

Heavy oil, Core-annular flow, Numerical simulation, Three phase flow

COMPUTATIONAL FLUID DYNAMIC ANALYSIS OF THE TESLA TURBINE

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Serbian-born inventor Nikola Tesla invented the Tesla turbine and patented it in 1913. The Tesla turbine is unique in the sense that it does not have any blades, also referred to as “bladeless turbine”. The working was based on the establishment of the fluid boundary layer. The original Tesla turbine consisted of multiple smooth discs. With the passage of flow, a boundary layer establishes and skin friction drag provides necessary force for rotation. Since the discs are relying primarily on skin friction drag, this type of turbine can function effectively under low-pressure differences. Another advantage of the Tesla turbine is that it can achieve very high rotational speeds ‘rotations per minute (RPM)’. Hence it is ideal for applications where high speeds are required. It is proposed in this work to conduct computational fluid dynamics analysis of a Tesla turbine. The study will help in revealing its working principles and hence allows us to optimize its parts for various applications, such as harnessing tidal energy, geothermal energy, etc.

CFD, Tesla Turbine, Boundary Layer, Skin Friction Drag

COMPUTATIONAL FLUID DYNAMIC ANALYSIS OF THE TESLA VALVE

H. Eidesen, H. Khawaja
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Serbian-born inventor Nikola Tesla invented the Tesla valve (Tesla's Valvular Conduit) and patented it in 1919. The Tesla valve is unique in the sense that it does not have any moving parts, but it can work as a one-way valve. Nikola Tesla invented this unit without advanced mathematical models, nor with the help of modern computing power. The original Tesla valve consisted of a set of cavities and fluid-flow guides that allow flow with low resistance in one direction but result in a high resistance to flow in the opposite direction, hence building up a backpressure. The advantage of this valve is that it does not require any moving parts and hence makes it a vital invention for microfluidic applications and designing of fire-safe equipment. It is proposed in this work to conduct computational fluid dynamics analysis of Tesla valve. The study will help in revealing its working principles and hence allows us to optimize its parts for various applications, such as lab-of-chip, fire safety, etc.

CFD, Tesla Valve, Reverse Flow, Backpressure

DETECTION OF RED DYE IN DIESEL OIL USING UV-ABSORPTION AND SILICON PHOTO DETECTOR

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University of Tromsø- The Arctic University og Norway, Norway

Developing a sensitive and effective instrument for detecting the presence of red dye in diesel fuel is very advantageous for governments in preventing tax loss by controlling illegal use of the diesel fuel. The objective of this work has been to investigate and develop an instrument to detect red dye in diesel, based on the principle of absorption. The peaks of absorption in red and pure diesel fuel were measured with the help of UV-spectrometer (Lambda 6/ PECSS). Optical interference filters of wavelengths 405 nm and 616 nm were used to modify the spectral transmittance of an optical system with appropriate spectral absorption characteristics. Two simultaneous light beams of two different colours were sent into the diesel fuel and the transmitted light from the fuel censored by a silicon photo detector. The signal from the detector was then amplified with the help of three operational amplifiers (OP-177) and sent to an analog device (AD 538) which can perform division operation. The voltage produced when the violet light passes through the medium was divided when the red light passes through the medium in the one quadrant division unit (AD 538). The output voltage from the analog device was measured with the help of a digital multi-meter. The results show that the output voltages decreases with the increase in percentage of red dye in diesel fuel.

Red dye, Diesel fuel, Absorption, UV-spectrometer, Silicon photo detector

DEVELOPMENT OF AN OPTIMIZATION ROUTINE FOR A PURE COMPONENT CASCADE LNG LIQUEFACTION PROCESS

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UiT The Arctic University of Norway, Norway

Energy efficiency is an important element of efforts to reduce CO2 emissions, particularly in the case of large-scale industrial processes such as LNG liquefaction plants. Because of Norway´s strong commitment to limit domestic CO2 emissions the Melkøya LNG plant in Northern Norway was designed to maximize energy efficiency. The result of this design focus is that the specific energy consumption achieved by Melkøya is the lowest for any LNG plant world-wide. To facilitate the further investigation of energy efficiency in LNG liquefaction across a range of conditions a numerical model of a LNG process was developed in Matlab® using the CoolProp® properties package. The model was based on the used of three pure components refrigerants (R50, R290 and R1150) each with two pressure levels, intercoolers and internal heat exchangers. An accurate optimization routine is important when comparing performance across a range of operating conditions. Different optimization algorithms were implemented and tested including the Genetic Algorithm (GA) which is one of the most common stochastic optimization routines used in process simulation and incorporate probabilistic elements. The application of this model is to allow large set of design variables to be manipulated and optimized on a consistent basis for varying NG concentration, NG pressure, equipment performance, cooling medium temperature and number of internal heat exchangers. The results of the modelling work conducted in Matlab® were verified using the HYSYS® process modelling software to ensure consistency.

LNG, Optimization, Matlab®, Genetic Algorithm, Coolprop®, Energy Efficiency

IMPROVING MECHANICAL GRIP OF TYRES ON SNOW AND ICY ROAD SURFACES USING FINITE ELEMENT METHOD

S. Ludvigsen, H. Khawaja
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Harsh winter conditions are known to be one of the most challenging environments for driving. Although the number of fatal accidents is higher during the summer compared to the winter in Norway (according to Norwegian Highways Authority), the total number of accidents is higher in the winter season. These accidents mainly happen due to loss traction on snowy or icy road surfaces. The loss of traction happens because there is not enough friction between the road surface and the car's tyres. To date, tyre producing companies have focused on parameters such as rubber hardness, elasticity and the adding of spikes. However, these developments have not brought about a revolutionary change in road safety. This paper presents a way to improve the mechanical grip of the tyre in snow and icy conditions by altering the profile of the contact pressure between the tyres and the surface. To modify the contact pressure profile we are proposing to replace conventional air-filled tyres with airless tyres. This will allow the designer to modify the structure inside the tyres in such a way that it will provide a concentrated contact pressure profile. By doing this we can concentrate the forces due to the weight of the car directly down to the contact point instead of distributing them throughout the tyre contact area. This concentrated contact pressure will provide a larger stick region hence providing better traction performance. In this paper, we are proposing to conduct this design study using finite element method by ANSYS® Workbench.

Tyres grip, Airless tyres, Finite element method, ANSYS® Workbench

MULTIPHYSICS MODELLING OF POWDER COATING APPLICATIONS

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Up until today the development of many powder coating applications rather relies on trial and error methods than on knowledge-based optimization. In order to create the foundation for introducing model-based engineering methodology within the field, a detailed, validated model of the powder coating process has been created. It features a coupled solution of electro- static, fluid- and particle- dynamic effects that govern particle motion and deposition phenomena. In contrast to previously published standards, this recently completed software is capable of considering electro-static particle interactions and transient particle loading effects close to the electrode. Thus the simulator is specifically suited to optimize not only particle deposition efficiency at the substrate, but also to work out and compare pistol design options in terms of maximized particle surface charge density. Since the development effort has been closely accompanied by the conduction of coating experiments in a small coating chamber, a relatively wide range of validating data can be presented alongside the model. Simulations can now be used to develop coating equipment, which will accomplish better coating quality as well as higher coating efficiency.

Powder coating, Electrode, OpenFoam, Efficiency, Coating quality

PARAMETRIC STUDY OF STEAM INJECTION IN HEAVY OIL RESERVOIR: A NUMERICAL INVESTIGATION

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Steam flooding is an effective enhanced oil recovery alternative used in heavy oil reservoirs because it allows to reduce the viscosity and improve the mobility of oil in the porous medium resulting in increased oil recovery factor. Thus, this study aims to analyze the steam injection application in a heavy oil homogeneous reservoir, with characteristics of the Brazilian Northeast. Numerical simulations were performed using the CMOST - Computer Assisted History Matching, Optimization and Uncertainty Assessment Tool, to obtain simulations by a sensitivity analysis in order to study the influence of operational and reservoir parameters in the steam flooding efficiency, and with STARS - Steam, Thermal and advanced Reservoir Simulator to obtain the reservoir behavior. Analysis of results has showed the effects of the steam into the reservoir such as reducing in oil viscosity, gravitational segregation and, consequently, improved oil recovery. The analysis was performed using pressure, temperature and oil saturation distribution inside the porous medium during 11 years of injection. It was concluded that steam injection provides enhanced oil recovery, however, it must be deployed with suitable numerical simulation study to determine the best operation conditions of the method employed.

Numerical simulation, Oil reservoir, Steam flooding, Heavy oil reservoir

REVIEW OF PELTIER AND RESISTIVE HEATING ELEMENTS THROUGH INFRARED IMAGING

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The study includes the review of the heating elements to develop the fundamental understanding. The heating elements to be investigated are Peltier and Resistive types. Both have different working principles and they are used in various industrial applications for cooling and heating purposes. The Infrared (IR) wavelength is emitted by each object at a temperature above absolute zero. IR light is electromagnetic radiation that has a longer wavelength as compared to the visible light. It has a spectral range starting from the edge of the visible red light from 0.74 μm to 300 μm. The infrared spectral band has four sub-bands; near infrared (0.75–3 μm), medium wavelength infrared (3–6 μm) MWIR, long wavelength infrared (6–15 μm) LWIR and very long wavelength infrared (15–1000 μm) VLWIR. The working principle of IR camera is based on the thermographic imaging. A thermal signature is produced based on the emitted infrared radiations. These thermal radiations are captured by the detector elements of an imaging device such as an IR camera. In this work, the heat fluxes will be observed and compared using LWIR imaging. LWIR imaging will shed light on the thermal capability of the heating elements. The forward-looking infrared imaging camera and a compatible software will be used to acquire thermal images.

Heating Elements, Peltier, Resistive, Infrared

SIMULATION OF PHOTOELECTROCHEMICAL IMPEDANCE FOR WATER SPLITTING SOLAR CELLS

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Impedance spectroscopy constitutes a valuable tool to probe kinetics of various processes in physical, chemical and biological systems. The interpretation of impedance data is usually done by assuming a certain equivalent electrical circuit (EC) model and obtaining the respective parameters by fitting the simulation results to the measurement data. Although the EC model is physically insightful for classical dark Mott-Schottky impedance, the EC models for impedance of illuminated photoelectrode can rapidly become ambiguous [1]. Furthermore, the impedance data should in principle allow directly obtaining reaction rates and other basic physical parameters, instead of the effective EC resistances and capacitances. In this work, simulations of photoelectrochemical impedance spectroscopy based on drift-diffusion numerical model are presented. A procedure for extracting rate constant for water oxidation and recombination lifetime from impedance measurements is discussed. Validation of our model with measured data for hematite proves challenging due to uncertainties in values of some material parameters.

[1] M. Orazem and B. Tribollet, Electrochimica Acta 53, 7360–7366 (2008)

Hydrogen, Water splitting, Impedance, Solar cell, Electrochemistry

SOLUTION OF PURE SCATTERING RADIATION TRANSPORT EQUATION USING FINITE DIFFERENCE METHOD

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Radiative transfer is the physical phenomenon of energy transfer in the form of electromagnetic radiation. The propagation of radiation through a medium is affected by absorption, emission, and scattering processes. Equations of radiative transfer have application in a wide variety of subjects including optics, astrophysics, atmospheric science, and remote sensing. Analytic solutions to the radiative transfer equation (RTE) exist for simple cases but in more realistic media, with complex multiple scattering effects, numerical methods are required. In the RTE, six different independent variables define the radiance at any spatial and temporal point. By making appropriate assumptions about the behavior of photons in a scattering medium, the number of independent variables can be reduced. These assumptions lead to the diffusion theory (or diffusion equation) for photon transport. In this work, the diffusive form of RTE will be discretized using Finite Difference Method Forward Time Central Space (FTCS) method and solved in MATLAB®. The results reveal the penetration intensity of the photons and validate the inverse-square law.

Radiation Transport Equation (RTE), Forward Time Central Space (FTCS), MATLAB®

STUDY OF ACOUSTICS PROPERTIES OF SK ONE COMPONENT POLYURETHANE AND ITS APPLICATION IN ARCTIC MARINE STRUCTURES

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Marine noise reduction tends to be challenging and requires a comprehensive engineering approach. The soundproofing materials for marine noise reduction are usually exposed to high temperatures, potential fluid or oil spills, engine maintenance and a high airflow environment. This work looks into the acoustic proofing properties of a non-toxic material 'SK One Component Polyurethane' developed by China Institute of Water Resources & Hydropower Research (IWHR) in Beijing. It is intended to perform experimental and numerical analysis in this research. In the acoustic proofing test, energy absorption property of material will be tested under the influence of acoustic waves and for Sound Transmission Class (STC) for a large range of frequency (low, mid and high frequencies). In addition, numerical model will be set up to perform Statistical Energy Analysis (SEA). SEA has proven to solve vibratory behaviour of complex structures. It is reported that higher frequency (i.e. shorter length-scale) modes are more sensitive to the inevitable small variations in structural details, even in nominally identical structures. Hence, it is more challenging to predict structural behaviours reliably; however, with development in currently existing SEA method, these can be captured. LS DYNA® simulation software will be used to model the acoustic behaviour. The study will provide reliable data on vibrations, isolating element, acoustic proofing properties and solving high-frequency structural acoustic-vibration problems of Marine structures. These results will be extremely valuable for predicting the environmental impact of the ever-increasing sea traffic in the Arctic region.

Acoustics Properties, SK One Component Polyurethane, STC, SEA, LS-DYNA®

STUDY OF ICE ADHESION BEHAVIOR OF SK ONE COMPONENT POLYURETHANE

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Ice adhesion causes many serious problems such as aircraft accidents, navigational issues on ships, and power loss on wind turbines. These challenges are mainly associated with the acute behavior of ice adhesion. The ice adheres when water seeps into the microscopic pores of the material substrate and freezes, thereby, forming an interlocking mechanism. Therefore, surface roughness has a significant effect on ice adhesion.
In this study, an effort is being made to look at the ice adhesion over a non-toxic material called SK One Component Polyurethane (SOCP) developed by China Institute of Water Resources & Hydropower Research (IWHR) in Beijing. The experimental analysis of ice adhesion will be carried out using four-point bending test set up in a cold room. The model will also be analysed theoretically using Euler–Bernoulli beam theory and the rule of mixtures. The experimental results will contain strain data gathered by a data acquisition system using LabVIEW® software. In addition, numerical simulations will be performed using ANSYS® Workbench simulation software. The study will provide reliable data for ice adhesion and build the basis for the application of SK One Component Polyurethane (SOCP) in the cold climate conditions.

Ice Adhesion, SK One Component Polyurethane (SOCP), Four-point bending test, ANSYS® Workbench

STUDY OF MATERIALS' IMPACT PROPERTIES FOR ARCTIC MARINE STRUCTURES

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It is well understood that sea ice is one of the biggest problems for the safety and reliability of ships and marine structures operating in the Arctic. Specially designed ships, also known as 'icebreakers', are usually used to clear ice to make way for merchant and cruise ships. Even then, the ship's staff must be extremely careful with speed and steering. Heavy impacts of ice result in fatigue and damage in the hull, which may lead to serious damage to the integrity of the ship. This work is to study materials that may be applied to the ship hull for providing an extra layer of protection. This study looks at the impact resistive properties of two different materials. The first material considered is carbon fiber reinforced polymer (CFRP). CFRP is proven for its strength to weight ratio and already in use in many applications, such as aviation industry, professional sports, etc. The second material is a non-toxic material 'SK One Component Polyurethane (SOCP)' developed by China Institute of Water Resources & Hydropower Research (IWHR). This material is light and can be applied as a coating. Also, this material has proven to have good abrasion resistance even in temperatures as low as -45°C. In this work, we plan to perform experimental and numerical analysis. In an experimental study, diabolo pellets of 0.5 g will be fired at a speed of 160 m/s on the samples of CFRP and SOCP using an airgun. The tests will be carried out on various thicknesses of materials and in a cold room where low-temperature conditions can be reproduced. In the numerical study, simulations will be performed using ANSYS® Workbench simulation software. The study will reveal the impact resistive properties of the materials, which will help identify their application towards marine applications in the Arctic region.

Impact, CFRP, SK One Component Polyurethane (SOCP), Airgun, ANSYS®

THERMAL PROPERTIES OF SK ONE COMPONENT POLYURETHANE USING EXPERIMENTS AND MULTIPHYSICS SIMULATIONS

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This study proposes to determine the thermal conductivity of SK One Component Polyurethane (SKOCP) developed by China Institute of Water Resources & Hydropower Research Beijing IWHR-KHL Co. Ltd. SKOCP provides excellent proof of aging and chemical resistance of this material. It is non-toxic, acts as a good anti-seepage, offers anti-abrasion and good anti-freezing performance. In addition, it has high strength, high elongation and good bonding with base materials (i.e. concrete, metal surfaces, etc.).With all these robust properties, the one component polyurethane seems the most favourable material for construction in cold regions as it acts as anti-freezing and protects against freeze-thaw fractures. The research aims to study SKOCP in depth and to determine its thermal conductivity using experimentations and multiphysics based numerical simulations. The standard experimental setup, as suggested by Kvadsheim, Folkow et al. (1994), will be used to determine the thermal conductivity. In addition, infrared imaging technique will also be employed to study the thermal profiles, which will indicate the thermal flux released into the surroundings (Rashid, Khawaja et al. 2016). This thermal flux will hence be used to estimate the heat transfer coefficient. The thermal data will be compared against the multiphysics numerical simulation results. The study will help in building the confidence between the experimentation and multiphysics based numerical studies and provide scientific background for application of SKOCP in the North.

Kvadsheim, P., et al. (1994). "A new device for measurement of the thermal conductivity of fur and blubber." Journal of Thermal Biology 19(6): 431-435

Rashid, T., et al. (2016). "Determination of Thermal Properties of Fresh Water and Sea Water Ice using Multiphysics Analysis." The International Journal of Multiphysics 10(3): 277-291

Thermal Conductivity, SK One Component Polyurethane, Infrared Imaging, Multiphysics

TOWARDS THE MODEL BASED DEVELOPMENT OF A COMBINED WOOD- AND COAL GASIFICATION REACTOR

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Wood gasification is a thermo-chemical process in which wood is decomposed into gaseous components such as methane, hydrogen, carbon monoxide, carbon dioxide and water as well as solid charcoal. A secondary but simultaneously running process in this context is coal gasification, where the residual charcoal under oxygen exposure in turn reacts to carbon monoxide or carbon dioxide. Depending on process parameters like temperature, air- or water supply rate, a thermo-chemical system can favour either typical wood-gasification, or typical coal-gasification reactions. The assumption is that a device, capable of deliberately switching between the two modes of operation would be more robust and flexible with respect to changing wood input quality. In order to gain more knowledge about the exact conditions required to run the process in either one of the two modes, a thermo-chemical, fluid-dynamic model of the combined processes was created using system dynamic principles. The transient 1D model is based on species balances, the minimization of molar Gibbs free energy of formation of the chemical compounds as well as kinetic considerations. An experimental wood gasifier was built to validate the predictions of the model regarding the state of the gasification process, based on temperature profile measurements. There is a high degree of agreement between the computational results and experimental data. Furthermore the model provides deep insight into the transient evolution of the different chemical reactions and thus also knowledge about limiting parameters. The latter can be used to improve the process in oncoming design phases.

Wood gasification, Coal gasification, Model, Reactor, System dynamics

WATERFLOODING PROCESS IN AN IRREGULARLY SHAPED OIL RESERVOIR: A FINITE-VOLUME APPROACH

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Oil reservoirs are porous and permeable rocks that allow the hydrocarbon accumulation. Reservoir simulations are necessary to obtain the best fluid flow conditions in the porous medium and increase oil recovery capacity. The aim of this paper was to study the influence of the absolute rock permeability on the oil recovery of a complex geometry oil reservoir, using water injection with the black oil model. Numerical simulations in bourdary-fitted coordenates were perfomed in a two-dimensional and irregularly shaped reservoir. Finite volume method was used to solve the governing equations and two inverted five-spot meshes were set in parrallel for a total injection time of 30 years. Results of injected porous volume per recovered oil volume, the water cut charts and the water saturations maps showed that the lower porous medium permeability increased the oil recovery, once the permeability intensified fingers and early breakthrough, which leads to high water production rates and consequent reduction of the waterflooding efficiency.

Numerical simulation, Waterflooding, Heavy oil reservoir, Bourdary-fitted coordenates, Absolute rock permeability

WATERFLOODING STUDY IN HEAVY OIL RESERVOIR WITH COMPLEX GEOMETRY: INFLUENCE OF THE INJECTED WATER RATE AND WELLS LOCATION

Balbina Raquel de Brito Correia[1], Bárbara Cynthia Carnaúba dos Santos[1], Antonio Gilson Barbosa de Lima[1], Brauner Gonçalves Coutinho[2]
[1]Federal University of Campina Grande, Brazil, [2]State University of Paraíba, Brazil

In the waterflooding process, injected water rate into the reservoir is directly correlated to pressurization of the porous medium and the efficiency of the oil displacement from the voids pores to the producing wells, and thus increased oil recovery. Well design, on the other hand, is determinate to waterflooding feasibility once the location of producing and injection wells enables take advantage of the characteristics of the reservoir to increase oil recovery. Thus, this paper aims to study the effect of the water injection rate and wells locations to improve oil recovery in heavy oil reservoir. The governing equations (black oil model) was written in boundary-fitted coordinates and it was discretized using finite-volume for a complex geometry. Numerical simulations were carried out changing injected water rate in 250, 350 and 450 m³/day and the distances between injection and production wells. Evaluated results by oil recovery and water cut graphs, and water saturation and pressure in the reservoir maps had showed that lowest absolute permeability of the porous medium and increased injected water rate caused improvement in efficiency of the waterflooding process until 40% of oil recovered for a specified producing well due to reduction of the fingers and early breackthrough. It was verified that injected water rate of 450 m³/day and distance between the producing and injection wells over 500 meters have proved to be the best condition for water injection method in the heavy oil reservoir, with low absolute permeability.

Reservoir simulation, Finite-volume, Waterflooding, Complex geometry, Well location

SESSION 2.1

IMPACT AND EXPLOSIONS

FRIDAY 9 DECEMBER 2016
10:00 – 11:00

CHAIR

E Albahkali
King Saud University
KSA

COMPUTATIONAL SIMULATION OF RAIN-INDUCED DAMAGE IN WIND TURBINE BLADES

B. Amirzadeh[1], N. Navadeh[2], A. Louhghalam[1], M. Raessi[1], R. Hewson[2], M. Tootkaboni[1], A. S. Fallah[2]
[1]UMass Dartmouth, USA, [2]Imperial College London, UK

In the past decade, due to the growing interest in renewable energies, the power output of wind turbines has increased significantly. This increase has been primarily achieved through manufacturing blades of greater dimensions. The large size of the blades, however, results in very high blade tip velocities which increases the susceptibility of blades to rain erosion. This work presents a computational framework that combines a model of the rain texture and high fidelity simulations of the impact between the raindrops and the blade coating with fatigue damage and fatigue stress-life estimation for rain erosion prediction in wind turbine blades. First, a stochastic model of the rain texture is developed that generates three-dimensional fields of raindrops, consistent with the rainfall history at the site of the farm where the turbine is located, through integrating micro-structural properties of rain with its integral properties such as the relationship between the average volume fraction of raindrops and the rain intensity. A fully coupled finite element model of rain drop-blade coating interaction is then developed to calculate the impact-induced stress waves propagating within the blade's coating layer and the ensuing fatigue damage pattern with high fidelity. The analysis is complemented with a fatigue stress-life estimation process that integrates elements of fatigue life calculation with 3D fields of raindrops generated from the rain texture model to relate damage accumulation rates to rain intensities. These accumulation rates, together with the statistics of rainfall history, are finally used to provide an estimation of the expected fatigue life of the blade coating as an indication of the onset of surface roughening or the end of the incubation period.

Wind turbine blade, Rain-induced erosion, Stochastic rain texture, Fully coupled drop impact simulation, Fatigue analysis, Damage accumulation rate

SIMULATIONS OF PARTICLE COLLISIONS IN A NON-NEWTONIAN FLUID

Henrik Nordborg, Matthias Pasquon, Boris Ouriev
HSR University of Applied Sciences, Switzerland

We consider the problem of a ball mill filled with a non-Newtonian fluid in addition to the material to be ground. This fluid obviously slows down the motion of the balls, leading to weaker collisions and reduced efficiency. We consider the problem from the point of view of scaling laws and dimensional analysis in order to find the absolute physical limits of the process. In addition, we discuss various simulation approaches and present first results from numerical simulations with EDEM coupled to fluid flow.

FSI, Non-Newtonian, Particle methods, EDEM, CFD

COMPUTATIONAL SIMULATION OF SOFTEN OF FOOD BY FOOD PROCESSING MACHINE USING UNDER SHOCK WAVE

Ken Shimojima, Yoshikazu Higa, Hirofumi Iyama, Ryou Henzan, Toshiaki Watanabe, Shigeru Itoh
National Institute of Technology, Okinawa College, Japan

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. An apple has been selected as the target of softening. First, the Us / Up of apple is calculated experimentally. The interior of the pressure vessel is modeled, the propagation of the shock wave was calculated by computational simulation. On the other hand, food processing machine using electrical energy is developed. We crashed a apple experimentally, and evaluated the softening quantitatively. Numerical calculations and experimental results are compared.

Underwater shock wave, Pressure vessel, Simulation, Food processing

SESSION 2.2

ELECTROMAGNETICS

FRIDAY 9 DECEMBER 2016
11:30 – 13:00

CHAIR

K Shimojima
Okinawa College
Japan

ELECTROTHERMAL SIMULATION OF LARGE-AREA SEMICONDUCTOR DEVICES

Christoph Kirsch[3], Stéphane Altazin[2], Roman Hiestand[2], Tilman Beierlein[3], Rolando Ferrini[1], Ton Offermans[1], Lieven Penninck[2], Beat Ruhstaller[2,3]
[1]CSEM SA, Switzerland, [2]Fluxim AG, Switzerland, [3]Zurich University of Applied Sciences, Switzerland

The lateral charge transport in thin-film semiconductor devices is affected by the sheet resistance of the various layers. This may lead to a non-uniform current distribution across a large-area device resulting in an inhomogeneous luminance, for example, as observed in organic light-emitting diodes (Neyts et al., 2006). The resistive loss in electrical energy is converted into thermal energy via Joule heating, which results in a temperature increase inside the device. On the other hand, the charge transport properties of the device materials are also temperature-dependent, such that we are facing a two-way coupled electrothermal problem. It has been demonstrated that the addition of thermal effects to a purely electrical model significantly changes the results (Slawinski et al., 2011). We present a mathematical model for the steady-state distribution of the electric potential and of the temperature across one electrode of a large-area semiconductor device. The model consists of two coupled semilinear partial differential equations (PDEs) of reaction-diffusion type in two space dimensions. The source terms in these PDEs are given by one-dimensional analytical models for the stacked semiconductor materials between the electrodes. Numerical simulations are performed with this model, using the finite element method with linear Lagrange elements on triangular meshes. By post-processing of the numerical solution quantities such as the (lateral) electric current density distribution or the total device current may be computed. Parameter studies allow us to investigate the influence of geometry or material parameters on the device performance. These simulations are rather fast due to the coupled 1D-2D modeling approach -- therefore, more elaborate tasks such as parameter estimation or optimization also become feasible. This work was carried out within the LAOSS (Large Area Organic Semiconductor Software) project funded by the Swiss Commission for Technology and Innovation.

Sheet resistance, Joule heating, Finite element method

COUPLED CFD SIMULATION OF BACK-TRAVEL PROBLEM IN HIGH-VOLTAGE CIRCUIT BREAKER DEVELOPMENT

Xiangyang Ye, Mahesh Dhotre, Sami Kotilainen
ABB Switzerland Ltd., Switzerland

In the industry of transmission and distribution of electric energy, a high-voltage circuit breaker is used to interrupt short circuit current in order to protect power grids and apparatuses. Gas with sufficient dielectric and thermodynamic properties is used to extinguish the electric arc which occurs as the electric contacts are separated. In a high-voltage circuit breaker, especially in a puffer breaker, drive energy is used to carry out breaker operation against the pressure build-up caused through mechanical compression and thermal process with burning arc, hence, the movement of contacts is sensitive to the pressure change in the compression volume. Furthermore, the back-travel can cause dielectric problems between the arcing contacts. For understanding and analysis of this behavior, coupled CFD simulation with mechanical and electrical field simulation is introduced. In this paper, the interaction between mechanical dynamic behavior and the gas flow and arcing process in breaker is observed through the co-simulation. The dielectric recovery in terms of breakdown voltage is evaluated with the Leader tool for the back-travel problem. Simulation results and their comparison with measurements are shown and discussed.

Coupled CFD, Circuit breaker, Back-travel, Dielectrics

TOWARDS MODEL BASED RE-DESIGN OF THE COPPER ELECTRO-WINNING PROCESS

D. Brunner, G. Boiger

Zurich University of Applied Sciences, Switzerland

High purity copper, suitable for electrical applications, can only be obtained by electro-winning. One aspect of this process is its self-induced natural convection through density variations of the electrolyte at both anode and cathode. The eventual goal is to highlight convective effects as main copper-transport mechanisms between the copper-winning electrodes. In order to do this, first the full dynamic complexity of the process needs to be understood. Thus an OpenFoam® based 3D model of the process has been created. This finite-volume multiphysics approach, solves the laminar momentum and copper-ion species conservation equations, as well as local copper-ion conversion kinetics. It uses a Boussinesq approximation to simulate the species-momentum coupling, namely natural draft forces induced by variations of the spatial copper concentration within the fluid. The model shows good agreement with benchmark-cases of real-life electrochemical cells, found in literature. Now the software can be applied to investigate how different forced convection conditions affect the speed of the entire copper-raffination process.

Electro-winning, copper, OpenFoam, Boussinesq, Raffination

ELECTROSTATIC PRECIPITATORS – MODELING AND ANALYTICAL VERIFICATION CONCEPT

Donato Rubinetti[1], Daniel A. Weiss[1], Walter Egli[2],
[1]University of Applied Sciences Northwestern Switzerland, [2]EGW Software Engineering. Switzerland

Electrostatic precipitation (ESP) is a reliable technology to control emissions of airborne particles in a series of applications, such as coal-fired power plants, cement plants or even for domestic fireplaces. In this Multiphysics application electrostatics and fluid dynamics play the dominant roles. A concept for modelling and numerical simulations of ESP is presented, verified and validated. The numerical model is divided into three coupled studies for i) the fluid dynamics, using Navier-Stokes equations for turbulent flows, ii) electrostatics, neglecting magnetic effects in Maxwell's equations, and iii) particle motion, governed by mechanical drag and electrical Coulomb forces, including time- and field-dependent particle charging processes. The air ionization process by corona discharge is taken into account by coupling Poisson's equation with the continuity equation for space charge density. The corresponding boundary condition for the emitting electrodes relates the electric field to the space charge density, in order to constrain the electric field to a characteristic given value. This analysis provides a robust and time-efficient approach for calculating electrostatic precipitators and related applications. The results for the electric field and the space charge density have been analytically verified. Furthermore, the model presented has been adapted and its results compared to experimental data from literature, showing a remarkable agreement.

Electrostatic precipitation, Corona discharge, Particle charging, CFD, Electrostatics

SESSION 2.3

ADVANCED MODELLING TECHNIQUES

FRIDAY 9 DECEMBER 2016
14:00 – 15:30

CHAIR

M Souli
Université de Lille
France

MULTI-PARAMETER OPTIMIZATION METHOD FOR THE DESIGN OF POROUS DIAPHRAGMS APPLIED IN PH-MEASUREMENT

G. Boiger, T. Ott
Zurich University of Applied Sciences, Switzerland

Many PH-measurement electrodes rely on porous diaphragms to create a liquid electrolyte junction between reference-electrolyte and the fluid to be measured. In field applications, the diaphragm is required to meet partly contradictory optimization criteria. To minimize measurement errors and ensure longevity of the measurement device, the diaphragm is supposed to maximize electrolyte conductivity and reference-electrolyte outflow velocity, while simultaneously minimizing reference electrolyte flow rate. The task of optimizing the over-all performance of this little piece of ceramics has lead to the development of a novel multi-parameter optimization scheme. The method encompasses the consideration of microscopic material design parameters, such as porosity, pore diameter, pore tortuosity and constrictivity, the macroscopic material parameters diaphragm diameter and length, as well as process parameters like internal electrode pressure or the electrolyte fluid properties. Comprising several parameter-sets to dimensionless groups, the introduction of a multi-dimensional design space is proposed, which allows the improvement of each possible diaphragm-based measurement set-up, by considering the simultaneous interaction of all relevant design-parameters.

PH, Diaphragm, Optimization, Liquid junction, Tortuosity, Constrictivity

DEVELOPED NUMERICAL APPROACH OF THE MELT-CRYSTALS PHASE-CHANGING KINETICS IN SOLIDIFICATION PROCESS

Yasser Safa, Thomas Hocker
Zurich University of Applied Sciences, Switzerland

A phase changing model describing the heat transfer and the interconversion between melt and crystal polymorph is implemented. A new enthalpy-formulated coupling between the phase kinetics equations and the Stefan problem is introduced. The stable numerical solving is achieved with a new implementation of the Chernoff scheme. This is based on an enthalpy formulation of mixture through a perturbation around the heat values of the stable crystal polymorph constitution. This developed model allows to predict the temperature, the crystal evolutions and the corresponding changes in the properties of the solids produced through process like cold molding, tempering and seeding, and further, this allows to derive relationships that can aid in process design. The computational simulations are informed, for input data, from DSC (Differential Scanning Calorimetry) tests that characterize the kinetic of crystal polymorphism. The variation of the total solid fraction obtained from numerical simulation is found in agreement with the values obtained from NMR (Nuclear Magnetic Resonance) measurements. Moreover, the model is validated also with respect to the measured temperature values in wind tunnel process. This approach that is applied in the field of chocolate manufacturing, is developed in the framework of collaborative research work between ICP institute at ZHAW, IFNH institute at ETH Zurich and some other industrial partners. Nevertheless the developed model is not limited to the chocolate industry, it can be also exploited in other manufacturing applications like polymer processing, cement manufacture and pharmaceutical industries.

Phase kinetics, Heat exchange, Solidifcation, Crystal polymorphism, Chernoff scheme

ON FREQUENCY BAND STRUCTURE IN ANISOTROPIC PHONONIC K3-METAMATERIALS

V. N. Gorshkov[1], N. Navadeh[2], M. Tootkaboni[3], A. S. Fallah[2]
[1]Los Alamos National Laboratory, USA, [2]Imperial College London, UK, [3]UMass Dartmouth, USA

Phononic metamaterials comprise locally resonant units arranged in a particular geometry of a substratum lattice and connected in a predefined topology. This study looks into band structure in two-dimensional anisotropic acoustic metamaterials involving mass-in-mass units connected by massless springs in K3 topology. Two sets of solutions for the eigenvalue problem |D(ω^2,k)|=0 are obtained and the existence of absolutely different mechanisms of gap formation between acoustic and optical surface frequencies is shown as a bright display of quantum effects such as strong coupling, energy splitting, and level crossings in classical mechanical systems. It has been concluded that a single dimensionless parameter i.e. dimensionless mass (μ) controls the order of formation of gaps between different frequency surfaces. If the internal mass of the phonon, m, increases relative to its external counterpart, M, then the coupling between the internal and external vibrations in the whole system rises sharply, and a threshold μ^* is reached so that for m/M>μ^* the optical vibrations break the continuous spectrum of "acoustic phonons" creating the gap between them for any value of other system parameters. The methods to control gap parameters and polarisation properties of the optical vibrations created over these gaps were investigated. Dependencies of morphology and width of gaps for several anisotropic cases have been expounded and the physical meaning of singularity at the point of tangential contact between two adjacent frequency surfaces has been provided. Repulsion between different frequency band curves, as planar projections of surfaces, has been explained. The limiting case of isotropy has been considered and it has been shown that, in the isotropic case, the lower gap always forms, irrespective of the value of relative mass.

Keywords: Phononic metamaterial, Frequency surface, Band structure, Bloch's theorem, K3 topology, Acoustic mode, Optical mode, Brillouin zone

ACOUSTIC STREAMING – NUMERICAL MODELING AND VALIDATION CONCEPT FOR ACOUSTIC STREAMING INDUCED BY ULTRASONIC TREATMENT

Donato Rubinetti, Daniel A. Weiss, Jonas Müller, Arne Wahlen
University of Applied Sciences, Northwestern Switzerland.

Acoustic streaming (AS) denotes the effect where a flow is driven in a fluid by the absorption of a sound wave. In order to have a significant effect in practice, the sound wave needs to have a high frequency (typically order of ultrasound) and high amplitude.
In metal processing industry this treatment is applied to obtain grain morphology adjustments during the solidification of metal. Improvement and further development of this technique focus on numerical modeling to reduce substantial costs for test rigs and field tests. This study presents a numerical model which takes into account the acoustics and fluid dynamics. An oscillating sonotrode is placed into the fluid, emitting high-amplitude ultrasound into the fluid. The distribution of the resulting sound field in the fluid gives rise to a body force, described by an additional source term in the momentum balance of the fluid. The results have been experimentally validated with a small-scale laboratory model using water, seed oil, and glycerin as sample fluids. By adjusting material properties a variety of fluids such as molten metal can be simulated. The concept presented for the numerical modeling of AS is numerically stable and accurate. It can be adapted to related applications involving sound-driven fluid motion.

Acoustics, CFD, Ultrasonic Treatment, Acoustic Streaming

SESSION 2.4

INDUSTRIAL CASE STUDIES

FRIDAY 9 DECEMBER 2016
16:00 – 17:30

CHAIR

T Rahulan
University of Salford
UK

A THERMO-, FLUID-DYNAMIC MODEL OF TRANSIENT HEAT DISTRIBUTION WITHIN PERFUSED HUMAN SKIN

T. Ott, G. Boiger, M.Bonmarin
Zurich University of Applied Sciences, Switzerland

Active thermal imaging is an interesting non-invasive method for skin cancer early diagnosis. In this technique, the skin is thermally stimulated and the skin surface temperature is monitored by an infrared camera. The goal is to be able to distinguish benign from malignant tumours due to their characteristic thermal response. In order to be able to interpret experimental data, a numerical thermo-, fluid- dynamic model of the human skin has been developed. The model features five different layers, with the three lowest ones being perfused. Thereby perfusion is modelled in dependence of heat flux history between blood vessels and surrounding skin. Several kinds of energy transfer are considered, such as surface radiation, surface air convection, heat conduction and perfusion within the skin as well as metabolic heat production. A system dynamics approach where all physical phenomena are dynamically coupled and transiently computed is applied to implement the model. The simulations have been shown to yield good agreement with previously published analytical solutions.

Skin cancer, Perfusion, Blood vessels, Thermal imaging, Thermo-fluid-dynamic model

SPH AND FEM FORMULATIONS FOR SOIL STRUCTURE EXPLOSIVE DETONATION

M. Souli[1], E. Al-Bahkali[2], I. Sharhrour[1], M. Moatamedi[3]
[1]Université de Lille, France, [2]King Saud University, Saudi Arabia, [3]The Arctic University of Norway, Norway

Simulation of detonation of explosive material in soil and its effect on surrounding structures can be considered as a soil structure-coupling problem. The application is mainly used in automotive and aerospace engineering and also in civil engineering. Classical FEM and Finite Volume methods were the main formulations used by engineers to solve these problems. For the last decades, new formulations have been developed for soil structure coupling applications using mesh free methods as SPH method, (Smooth Particle Hydrodynamic) and DEM (Discrete Element Method). Up to these days very little has been done to compare different methods and assess which one would be more suitable. In this paper the mathematical and numerical implementation of the FEM and SPH formulations for hydrodynamic problem are described. From different simulations, it has been observed that for the SPH method to provide similar results as FEM Lagrangian formulations, the SPH meshing, or SPH particle spacing needs to be finer than FEM mesh. To validate the statement, we perform a simulation of a hydrodynamic impact on an elasto-plastic plate structure. For this simple, the particle spacing of SPH method needs to be at least two times finer than FEM mesh. A contact algorithm is performed at the soil structure interface for both SPH and FEM formulations. In the paper the efficiency and usefulness of two methods, often used in numerical simulations, are compared.

SPH, Soil, Explosives, DEM

PATH FROM MULTIPHYSICS-THEORY TO SPIN OFF

Nils Reinke
Winterthur Instruments, AG, Switzerland

In this talk, we present the Spin-Off Company Winterthur Instruments AG of the Institute of Computational Physics, founded in 2011. The story yet successful road from first idea, over prototyping to a working business model.

Winterthur Instruments develops measurement systems for fast non-contact and non-destructive testing of industrial coatings. The technology of Winterthur Instruments is based on a combination of a patented, pulsed infrared transducer and model based data analysis. This measurement system can be used to determine coating thicknesses, material parameters (e.g. porosity) and contact quality (e.g. to detect delamination). The system is based on optical-thermal measurements and works with all types of coating and substrate materials. Our measurement system provides the unique opportunity of non-contact and non-destructive testing of arbitrary coatings on substrates.

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