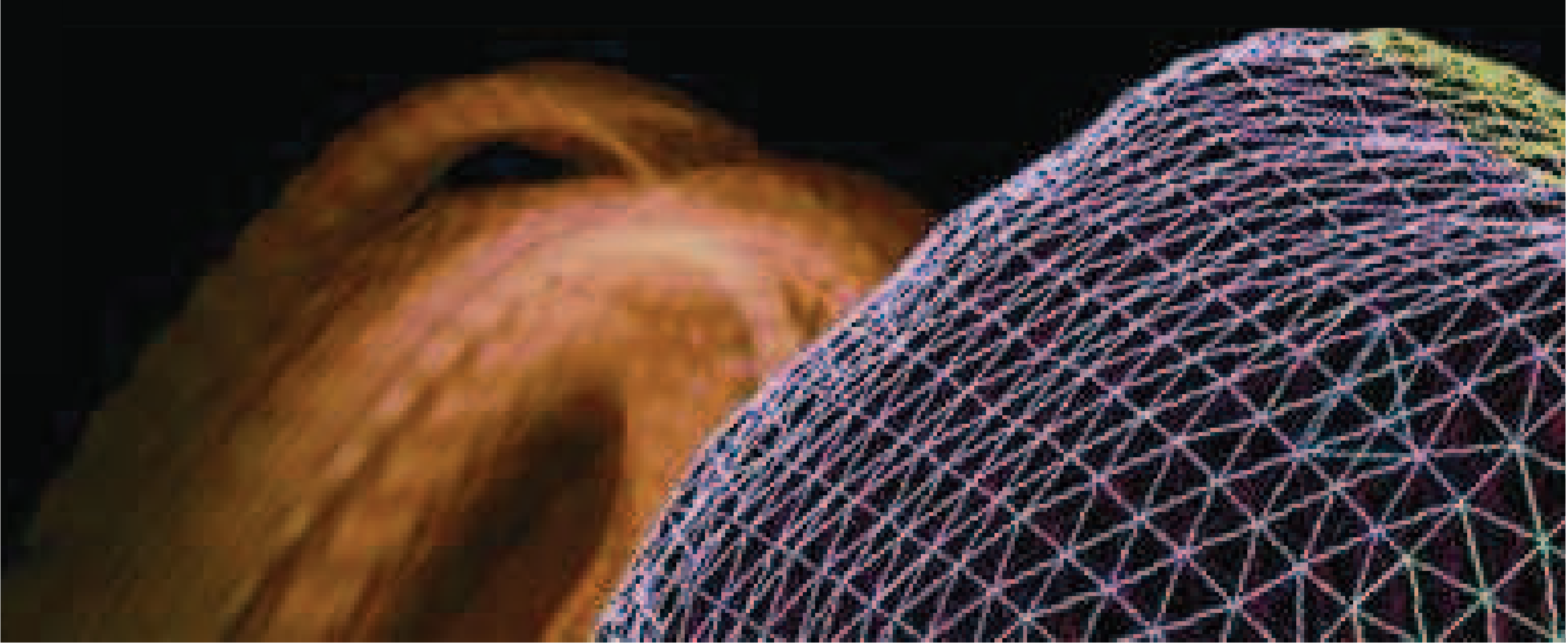
ISSN (Online) 2409-1669
ISSN (Print) 2409-7527

MULTIPHYSICS 2014

11 - 12 December 2014
Sofia, Bulgaria



MULTIPHYSICS 2014

11-12 December 2014
Sofia, Bulgaria

Conference Board

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, Soil, Structures and Thermodynamics.

Registration Pack – Collection Hours

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

Thursday, 11th December	11:00-17:30
Friday, 12th December	9:30-15:30

Special Events

Thursday 19:30
Conference Banquet

Timing of Presentations

Each paper will be allocated 18 minutes. A good guide is 14 minutes for presentation with 4 minutes left for questions at the end.

Good timekeeping is essential, speakers are asked to keep strictly to 18 minutes per presentation.

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

Selected papers will be reviewed and published in 'The International Journal of Multiphysics'.

Sponsorship

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

Keynote Speaker

Prof. Ali Tehrani,
Her Majesty Principal Inspector,
Office for Nuclear Regulation,
United Kingdom

BIOGRAPHY

Professor Ali Tehrani has post graduate degrees from the University of London (King’s College, MSc) and University of Exeter (Department of Engineering, PhD). He is a specialist nuclear safety regulator within Office for Nuclear Regulation (ONR) with over 25 years’ experience in the nuclear industry covering new generations of civil nuclear power plants. As a specialist member of the ONR’s Fault Studies Nuclear Topic Group he is concerned with the development, verification and validation of analysis methods covering lumped parameter, CFD and increasingly multi-physics codes used in dealing with complex and challenging plant performance characteristics, particularly in accident conditions. His work, as a specialist Inspector, with international regulators includes being UK regulatory representative on a number of International Working Groups covering initiatives such as the Sandia Fuels Project (SFP), THAI 2, and lead project officer on the International Standard Problem (ISP 49) benchmarking on hydrogen deflagrations to evaluate the modelling tools capabilities and limitations. As a Visiting Professor in the Department of Materials, Imperial College London (ICL), he supports the work of the Centre for Nuclear Engineering. He has been active in engaging and supporting the interdepartmental Collaborative project at ICL covering Severe Accident research.

MULTIPHYSICS 2014

PROGRAMME

TIME	Thursday 11 December 2014	Friday 12 December 2014
09:30 - 11:00		**Session 2.1** *Advances in Mathematical Modelling Techniques*
11:00 - 11:30	**Coffee Break**	
11:30 - 13:00	**Registration & Keynote Address**	**Session 2.2** *Developments in Multiphysics Methodologies*
13:00 - 14:00	**Lunch**	
14:00 - 15:30	**Session 1.3** *Multiphysics Developments in Industrial Applications*	**Close of Conference**
15:30 - 16:00	**Tea Break**	
16:00 - 17:30	**Session 1.4** *Posters*	
19:30	**Conference Banquet**	

Full Programme

Thursday 11 December 2014

11:30 – 13:00 Registration / Keynote Address

Keynote Address

The Use of Multiphysics to Predict Performance of Nuclear Plants in Accident Conditions

Prof. Ali Tehrani, Her Majesty Principal Inspector, Office for Nuclear Regulation, UK

Chair: M Moatamedi, Narvik University College, Norway

13:00-14:00 Lunch

Thursday 11 December 2014

14:00-15:30 **Session 1.2**
Multiphysics Developments in Industrial Applications

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

Continuous Hot Dip Galvanizing - Numerical Simulation of flow and temperature distribution inside a molten zinc bath based on ANSYS FLUENT®

M. Mataln, Materials Center Leoben Forschung GmbH, Austria
C. Pfeiler, Materials Center Leoben Forschung GmbH, Austria
J. Strutzenberger, voestalpine Stahl GmbH, Austria
G. Angeli, voestalpine Stahl GmbH, Austria

Pre-processing Technology for Marine Products Freeze-drying Using Shock Loading

Toshiaki WATANABE: Dept. of Ocean Mech. Eng., Nat. Fisheries Univ., Japan
Hironori MAEHARA: Institute of Pulsed Power Science, Kumamoto Univ., Japan
Shigeru ITOH: Okinawa National College of Tech., Japan

Failure of an Aircraft Seat Support Tube

Essam A. Al-Bahkali, Hisham Elkenani, King Saud University, KSA
Mhamed Souli, Laboratoire de Mécanique, de Lille, France

Performance Study of Flat and Corrugated Porous Fences Using CFD Techniques

Yizhong Xu, Mohamad Y. Mustafa, Jason Knight, Muhammad S. Virk and George Haritos, Narvik University College, Norway

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

Thursday 11 December 2014

16:00-17:30 Session 1.3
Posters

Water/Oil Separation Process Using a Concentric Tubular Ceramic Membrane Module a Numerical Investigation

Acto de Lima Cunha, Federal University of Sergipe, Campina Grande, Brazil
Severino Rodrigues de Farias Neto, Antonio Gilson Barbosa de Lima, Enivaldo Santos Barbosa, Josedite Saraiva de Sousa, Federal University of Campina Grande, Campina Grande, Brazil

Applying GBI Method to predict Heat and Mass Transfer in Ceramic Plate

I. B. dos Santos, University of Paraíba, Campina Grande, Brazil
V. S. Silva, Federal University of Campina Grande Campina Grande, Brazil
F. P. M. Farias, Federal University of Campina Grande, Sumé, Paraíba, Brazil
A. G. B. de Lima, Federal University of Campina Grande, Campina Grande, Brazil
W. M. P. B. de Lima, Federal University of Campina Grande, Campina Grande, Brazil

Numerical Study of Two Phase Flow (Air-Water) in Horizontal Pipelines with Multiple Leaks in Transient State

Jamerson W.S. Costa, Cristiane H. Sodre, William G. Vieira, Pedro H.C. De Melo, F. De Oliveira, Joao V.O. Muniz, Universidade Federal de Alagoas, Maceio-Al- Brazil
Antonio Gilson Barbosa de Lima, Federal University of Campina Grande, Campina Grande, Brazil

Involvement of Multiphysics in Petroleum Research: Case Study on Shock Tube Experimental Setup

H. Khawaja, The Arctic University of Norway, Tromsø, Norway
M. Moatamedi, Narvik University College, Narvik, Norway

Multi-fluidic Simulation using Multiphysics tools: Case Study on a LNG Plant

H. Khawaja, T. Schive, K. Edvardsen, The Arctic University of Norway, Tromsø, Norway

Study of Refrigerants for Cold Climate Heat Pump Operations

H. Khawaja, E. Brodal, S. Jackson, The Arctic University of Norway, Tromsø, Norway

Design of a Snow Sledge using Multiphysics Analysis

H. Xue, G. Mauseth, Narvik University College, Narvik, Norway
H. Khawaja, The Arctic University of Norway, Tromsø, Norway

Infrared Detection for Anti-Icing Systems in Ship Operations

T. Rashid, H. Khawaja, Kåre Edvardsen, The Arctic University of Norway, Tromsø, Norway

Linear description of the nonlinear reality

R. Wojnar, Polish Academy of Sciences, Warszawa, Poland

Radar image feltring approach based on the co-occurrence Matrix

O. Raaf and A. E. H. Adane, France

Theoretical and Analytical Study of Behaviour of Wave Propagating Through Homogeneous Copper Sulphide Thin Film

Emmanuel Ifeanyi Ugwu, Dept. of Industrial Physics, EBSU,P.M.B. 53, Abakaliki, Nigeria

A Genetic Algorithm Approach for Estimating Processes Derivatives in On-line Optimization

Moufid Mansour AND Ali Affak, UK

Vulnerability Assessment of RC Buildings

F. Imene. Belheouane, University of blida, Algeria

19:30 Conference Banquet

Friday 12 December 2014

09:30-11:00 **Session 2.1**
Advances in Mathematical Modelling Techniques

Chair: L. Dechevski, Narvik University College, Norway

Supercritical and Critical Cases for 2D and 3D BVP for Quasi-linear Equations of Mixed Elliptic-Hyperbolic Type

Nedyu Popivanov, Faculty of Mathematics and Informatics, University of Sofia, Bulgaria

Recurrent Sequences in Solving The Schrödinger Equation

A.F. Polupanov, Moscow State University of Psychology and Education, Moscow, Russia

Surface hole modeling using blending splines

Aleksander Pedersen, Jostein Bratlie and Rune Dalmo: Narvik University College, Norway

Infinitely Smooth GERBS-Based Partition of Unity as Intrinsic Tool of Iso-Geometric Analysis on General Splits and Covers of Multidimensional Domains

L. Dechevski, Narvik University College, Norway

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

Friday 12 December 2014

11:30 – 13:00 Session 2.2
Developments in Multiphysics Methodologies

Chair: E. A. Al-Bahkali, King Saud University, Saudi Arabia

Multiphysical Approach in Development of Models of Deformation and Fracture of Polymers

L.A. Merzhievsky, Lavrentyev Institute of Hydrodynamics, Novosibirsk, Russia

System dynamic modelling approach for resolving the thermo-chemistry of wood gasification processes

G. Boiger, ICP Institute of Computational Physics, Zurich University of Applied Sciences, Switzerland

An Improved Model for Estimating Fractal Structure of Silica Nano-Agglomerates in a Vibro-Fluidized Bed

N. Mostoufi, College of Engineering, University of Tehran, Tehran, Iran

SPH and ALE methods for Membrane Inflation

Essam Albahkali, Hisham Elkenani, King Saud University, Saudi Arabia
Mhamed Souli, University of Lille, France

13:00-14:00 Lunch

14:00 Close of Conference

SESSION 1.1

KEYNOTE ADDRESS

THURSDAY, 11 DECEMBER 2014
11:30 – 13:00

CHAIR

M Moatamedi
Narvik University College
Norway

Thursday, 11 December 2014
11:30 – 13:00

Keynote Address

The Use of Multiphysics to Predict Performance of Nuclear Plants in Accident Conditions

Prof. Ali Tehrani,
Her Majesty Principal Inspector,
Office for Nuclear Regulation,
United Kingdom

The growth of nuclear industry and an outlook of the UK nuclear new build programme have highlighted simulation needs to predict plant performance in accident conditions. A significant challenge in the nuclear industry is the modelling and simulations of phenomenon that may occur as a result of core degradation, melting of fuel and its relocation post-accident conditions.

One such event is the prolonged loss of cooling within a nuclear reactor, which will challenge the integrity of internal structures and may lead to the melting of materials and its relocation to lower part of the reactor vessel. This will form a debris bed, which consist of fragments from the fuel cladding, pellets that constitute the nuclear fuel and supporting structure. If this debris is not cooled within the reactor pressure vessel, this mass will begin to degrade and ultimately breach the vessel. The debris may interact with the concrete and ex-vessel cooling of the melt is required to prevent its progression.

This talk will focus on the challenges resulting from nuclear accidents; modelling approach offered by Multiphysics and covers a number of examples. Experimental work and supporting validation of the numerical codes are essential to develop confidence in the safety justification of these plants. These aspects and comparison between experiments and numerical analyses will also be discussed to highlight some of the challenges in this area.

SESSION 1.2

MULTIPHYSICS DEVELOPMENTS IN INDUSTRIAL APPLICATIONS

THURSDAY 11 DECEMBER 2014
14:00 – 15:30

CHAIR

G Boiger
Zurich University of Applied Sciences
Switzerland

CONTINUOUS HOT DIP GALVANIZING - NUMERICAL SIMULATION OF FLOW AND TEMPERATURE DISTRIBUTION INSIDE A MOLTEN ZINC BATH BASED ON ANSYS FLUENT®

Corresponding Author

Marianne Mataln

marianne.mataln@mcl.at

Authors and Affiliations

M. Mataln, C. Pfeiler, Materials Center Leoben Forschung GmbH, Austria

J. Strutzenberger, G. Angeli, voestalpine Stahl GmbH, Austria

Continuous hot dip galvanizing is one of the fastest growing technologies for surface treatment of steel strips. The main challenge is to produce high quality zinc-coated surfaces with superior corrosion resistance as the industry quality standards are steeply rising every year. Until now, the development of this technology was performed empirically. For a full understanding of the process it is necessary to draw a detailed attention on the each influencing parameter and also material related phenomena. This is only possible by applying numerical methods. In this publication, the focus is set on the center process step: the continuous dipping of the steel strip into the molten zinc bath after heat treatment in an annealing furnace. The numerical simulation is conducted by application of the commercial Computational Fluid Dynamics (CFD) software package ANSYS FLUENT®, which is based on the well-known Finite Volume Method. In the first part, modelling of the 3D turbulent, buoyancy driven fluid flow is described, where it will be shown that the application of the suitable turbulence model is essential. In the next step, the simulation of the temperature distribution inside the inductively heated molten zinc bath is illustrated. As the resulting temperature distribution in the bath highly influences the reactions on the steel strip and also the formation of undesired dross particles, it is vital to sustain accurate results. This is realized by calculating the required thermal boundary conditions of the surrounding bath walls on the basis of specific measurements and material properties. The resulting boundary conditions are validated by comparing the simulation results of the temperature field with experimental measurements. On the basis of the performed simulations it is possible to visualize the flow and temperature field for a detailed study and also to provide recommendations for optimization of process parameters.

Keywords: Computational Fluid Dynamics (CFD), Fluent, hot dip galvanizing, flow and temperature distribution, molten zinc bath

PRE-PROCESSING TECHNOLOGY FOR MARINE PRODUCTS FREEZE-DRYING USING SHOCK LOADING

Corresponding Author
Toshiaki WATANABE
watanabe@fish-u.ac.jp

Authors and Affiliations
Toshiaki WATANABE: Dept. of Ocean Mech. Eng., Nat. Fisheries Univ., Japan
Hironori MAEHARA: Institute of Pulsed Power Science, Kumamoto Univ., Japan
Shigeru ITOH: Okinawa National College of Tech., Japan

In the food industry, it is hoping high value-aided product and the increase in efficiency of food processing. On the other hand, we get an experimental result that the load of the shock wave improves an extraction of food, and soften food. We tried to examine the effectivity of the shock wave as pre-processing for freeze-drying from the result in permeation character seen in the radish and so on. In the case of freeze-drying , the object tends to be limited to the small or thin one with size, from the sublimability in processing, the performance in case of the restoration and the viewpoint of the cost performance ratio. Therefore, we used comparatively large beheaded shrimps and attempted to review the effectivity of the shock wave processing about being freeze- drying. The improvement of the sublimation speed was gotten from the result that the pressure change during freeze-drying processing and the improvement of the reconstitution was gotten from the result using hot water. It was expected that the reconstitution of the freeze-dried food is improved and that a processing time is abridged, by shock wave loading as pre-processing for freeze-drying. This phenomena will be modeled, and it will be compared with a result of an experiment.

Keywords: Freeze-drying, Shock Loading, Pre-processing

FAILURE OF AN AIRCRAFT SEAT SUPPORT TUBE

Corresponding Author
Essam Albahkali
ebahkali@ksu.edu.sa

Authors and Affiliations
Essam A. Al-Bahkali, Hisham Elkenani, King Saud University, KSA
Mhamed Souli, Laboratoire de Mécanique, de Lille, France

There have been increasing reports of annoyance, fatigue, and even neck and back pain during prolonged operation of a troop transport propeller aircraft, where persistent multi-axis vibration occurs at higher frequencies. A claim from failure of the aluminium tube used as a seat support tube (SST) for troop seat –wall style- construction. A failure occurs after about 85 flight hours. In the present work, a random vibration analysis is conducted using the mutiphysics software LS-DYNA capability. First, a static analysis is performed using a pressure load on part of the tube that represents the seating location, followed by random vibration analysis. A contact algorithm is added in order to transfer the support's movement to the tube. The actual Power Spectrum Density (PSD) profile are calculated according to the military standards MIL-STD-810G. Different fatigue methods have be used for the analysis of lifetime as it is proven to provide accurate results for large number of applications, both in automotive and aerospace industry.

Keywords: Fatigue, random vibration, seat support, contact

PERFORMANCE STUDY OF FLAT AND CORRUGATED POROUS FENCES USING CFD TECHNIQUES

Corresponding Author

Yizhong Xu

Yizhong.Xu@hin.no

Authors and Affiliations

Yizhong Xu, Mohamad Y. Mustafa, Jason Knight, Muhammad S. Virk and George Haritos, Narvik University College, Norway

In the offshore industry, flat porous fence system and corrugated porous fence system are classified as two basic types in the form of windbreaks to enable the control of natural climate. From the mechanical point of view, the flat porous fence is easy to be manufactured; while the corrugated one yields more strength if compared to the flat fence of the same thicknesses. From the fluid mechanics point of view, the corrugated porous fence encounters multidirectional wind attack at different angles, which produces more complex structures of velocity and turbulence behind the fence as compared to the flat type. Researches on the performance of these two types of porous fences are few. It remains of high industrial value to assess the performance of these two types of porous fences. In this paper, numerical fence models of these two types were created based on the commercial fence products provided by IKM dsc AS, Norway. The configurations of the domains and sizes of the fences are the same, as well as the inlet velocity profiles and the boundary conditions. The realizable k-Epsilon turbulence model with Non-Equilibrium Wall Function was employed in all of the CFD simulations. These procedures ensure the comparison criteria in all cases to be identical. The numerical results were in a good agreement with the comparable wind tunnel experimental results. The two different types of porous fences have been assessed through analysing velocity, turbulence intensity and reattachment length. The 3D CFD simulation can provide valuable information on the fence design with the advantages of flexibility and efficiency

Keywords: 3D CFD simulation; flat porous fence; corrugated porous fence; performance of porous fence

SESSION 1.3

POSTERS

THURSDAY 11 DECEMBER 2014
16:00 - 17:30

WATER/OIL SEPARATION PROCESS USING A CONCENTRIC TUBULAR CERAMIC MEMBRANE MODULE: A NUMERICAL INVESTIGATIONON

Corresponding Author

Antonio Gilson Barbosa de Lima
gilson@dem.ufcg.edu.br

Authors and Affiliations

Acto de Lima Cunha, Federal University of Sergipe, Campina Grande, Brazil
Severino Rodrigues de Farias Neto, Antonio Gilson Barbosa de Lima, Enivaldo Santos Barbosa, Josedite Saraiva de Sousa, Federal University of Campina Grande, Campina Grande, Brazil

One of the main problems associated to the membrane separation processes is the permeate flux decline, which limits the application of the process in different areas such as, petroleum, food, pharmaceuticals, biotechnology, treatment and supply water, due to the concentration accumulation near the surface of the ceramic membrane (concentration polarization). A quantification of the concentration polarization as a function of the process conditions is crucial for a satisfactory estimation of the system performance. In the present work we have developed a numerical study of the separation process via ceramic membranes. The study domain corresponds to a separation modules formed by four concentric tubes, where the internal one corresponds to the ceramic membrane. The system was applied to the treatment of water contaminated with oil. The separation module has a tangential effluent input and a tangential concentrate output; the filtered is collected inside the membrane after the filtration.

The numerical study considering a 3-D computational domain was carried out with aid of the commercial software ANSYS CFX 12. In the numerical assessment, we considered the porosity of the membrane as being constant and the permeability as a function of the resistance of the porous medium to the flow. Results of the pressure, velocity, oil concentration distribution inside the device, permeation velocity and pressure profiles at the surface of the membrane are presented and analyzed. The numerical results show that the mathematical model used was capable to predict deposition of the oil at the surface of the tubular membrane. The geometric effects of the separation module, supported by the system operation conditions, showed an important influence on the dispersion of the concentration polarization.

Keywords: Ceramic membrane, Separation, Two-phase flow, CFX

APPLYING GBI METHOD TO PREDICT HEAT AND MASS TRANSFER IN CERAMIC PLATE

Corresponding Author

Antonio Gilson Barbosa de Lima

gilson@dem.ufcg.edu.br

Authors and Affiliations

I. B. dos Santos, University of Paraíba, Campina Grande, Brazil

V. S. Silva, Federal University of Campina Grande Campina Grande, Brazil

F. P. M. Farias, Federal University of Campina Grande, Sumé, Paraíba, Brazil

A. G. B. de Lima, Federal University of Campina Grande, Campina Grande, Brazil

W. M. P. B. de Lima, Federal University of Campina Grande, Campina Grande, Brazil

Drying is a process of simultaneous heat and mass transfer, which happens in moist porous bodies. The optimized control of this process can prevent cracks, fissures and deformation, avoiding damage and increasing quality to the product post-drying, especially in clay materials. Thus, this paper aims to study drying of ceramic plates. Here is presented a mathematical model and its exact solution via Galerkin Based Integral Method (GBI method) to describe heat transfer and moisture migration during the drying process considering convective boundary condition. Results of the drying and heating kinetics and moisture content and temperature distribution inside the ceramic plates during the drying process are presented and analyzed. The results of the average moisture content have shown to be consistent with the experimental data. It was verified that the vertex of ceramic plate is a region that dry and heat quickly. Thus, this region is more susceptible to cracks and deformations, which reduces product quality.

Keywords: Clay, Analytical, Drying, GBI method

NUMERICAL STUDY OF TWO PHASE FLOW (AIR-WATER) IN HORIZONTAL PIPELINES WITH MULTIPLE LEAKS IN TRANSIENT STATE

Corresponding Author
Cristiane H.Sodré
chsodre@gmail.com

Authors and Affiliations
Jamerson W.S. Costa, Cristiane H. Sodre, William G. Vieira, Pedro H.C. De Melo, F. De Oliveira, Joao V.O. Muniz, Universidade Federal de Alagoas, Maceio-Al- Brazil
Antonio Gilson Barbosa de Lima, Federal University of Campina Grande, Campina Grande, Brazil

The transport of two-phase flow, gas and liquid through pipelines is used in many operations in the chemical and petrochemical industry . For petrochemical industry the pipelines network is responsible to transport the final products through many kilometers, sometimes buried or passing through small communities until reach the final costumer. Leaks in pipelines can occur due to a number of factors such as corrosion, mechanical fatigue, welding failures, sudden changes in pressure among others. This study aims to analyze the characteristics of two-phase flow (air-water) during isothermal steady-state flow and transient flow in horizontal tube in the presence of leaks. It was used the ICEM ANSYS software to generate the structured grids. The Euler-Euler approach and the k-ε turbulence along with the continuity, energy and moment equations were considering to solving the problem using ANSYS-CFX software. It was analysed at first one point of leak and further two distinct points of leakage were simulated at the same time along the pipe. The behavior of the variables pressure, velocity and volume fraction of the fluid were evaluated in order to acquire the characteristic for this type of problem profiles. Pressure drops due to the leakage were observed. For both steady and transient state the real water velocity tends to match to the surface water velocity in the leak section. This happen because the water becomes almost a pure phase in the presence of the leak because of the loss of air. For the air, the surface velocity tends to zero by the fact that a fraction tends to zero in the leak section.

Keywords: TWO-PHASE FLOW, AIR-WATER, k-ε TURBULENCE MODEL, ANSYS-CFX SOFTWARE

INVOLVEMENT OF MULTIPHYSICS IN PETROLEUM RESEARCH: CASE STUDY ON SHOCK TUBE EXPERIMENTAL SETUP

Corresponding Author
H. Khawaja
hassan.a.khawaja@uit.no

Authors and Affiliations
H. Khawaja, The Arctic University of Norway, Tromsø, Norway
M. Moatamedi, Narvik University College, Narvik, Norway

The case presented focuses on “shock tube experimental setup”. The shock tube produces normal shock wave by the sudden interaction of fluids at a pressure difference. In a shock tube, the high-pressure and low-pressure sections commonly referred to as the driver and driven sections interacts with each other by either an opening valve or a bursting disc. This can study some of the key problems faced today in petroleum industry such as water-hammer effect” and cavitation. The water hammer effect is a pressure surge caused when a fluid forced to stop or change direction suddenly. A water hammer commonly occurs when a valve closes suddenly at an end of a pipeline system, and a pressure wave propagates in the pipe. This pressure wave can cause major problems, from noise to vibration and eventually collapse of pipes and joints. Similarly, cavitation is also a challenge faced in petroleum industry. Cavitation is the formation of vapour cavities in a liquid. It usually occurs when a liquid subjects to rapid changes of pressure. Cavities forms when local pressure gets lower and implode generating shockwaves when local pressure becomes normal. This phenomenon is a significant cause of wear in various units in petroleum industry causing surface stresses through repeated implosions. The work discusses the use of Multiphysics tools to study the problems faced in petroleum industry such as discussed above. The study is supported by the shock tube experimental setup.

Keywords: Multiphysics, shock tube, water hammer effect, cavitation

MULTI-FLUIDIC SIMULATION USING MULTIPHYSICS TOOLS: CASE STUDY ON A LNG PLANT

Corresponding Author
H. Khawaja
hassan.a.khawaja@uit.no

Authors and Affiliations
H. Khawaja, T. Schive, K. Edvardsen, The Arctic University of Norway, Tromsø, Norway

The work focuses on “multi-fluidic simulation of a LNG Plant”. A pipeline quality LNG (Liquefied Natural Gas) contains minimum of 75 % methane (CH_4) with some heavier hydrocarbons and carbon dioxide. Natural gas of suitable quality is liquefied in order to reduce its volume and make it commercially viable for transport via sea vessels, transport vehicles, etc. In a LNG plant, a gas obtained from well goes through various processes before it is liquefied. The processes are referred to as field operations, inlet compression, gas treatment, dehydration, hydrocarbon recovery, nitrogen rejection, liquefaction, storage and transportation. Field operations may include upstream analysis, free liquid separation, dehydration, acid gas removal and compression. Inlet compression is performed to ensure the needed pressure for further operations. The gas treatment process removes CO2 and H2S contents from the gas. It is essential to remove these components to reduce the possibility of corrosion in the pipes and process plant equipment. Gas dehydration is performed to remove the water contents from the gas. Heavier hydrocarbon are separated from the gas in the hydrocarbon recovery operation. Nitrogen rejection process is used to separate gas from any leftover nitrogen in the stream. Liquefaction is performed on the gas by cooling and compressing the gas in multi stage processes. Liquefied gas is kept at low pressures and temperatures. Any cooling needed to maintain such conditions is achieved by vaporisation of liquefied gas, which is re-circulated in the liquefaction process. In this work, HYSYS® (a software based on equation of state, laws of conservation of mass and energy) is employed to simulate above given processes. The achieved results are discussed and conclusions are drawn.

Keywords: Multiphysics, Liquefied Natural Gas Processing, LNG Plant Processes

STUDY OF REFRIGERANTS FOR COLD CLIMATE HEAT PUMP OPERATIONS

Corresponding Author
H. Khawaja
hassan.a.khawaja@uit.no

Authors and Affiliations
H. Khawaja, E. Brodal, S. Jackson, The Arctic University of Norway, Tromsø, Norway

The paper focuses on study of refrigerants for heat pump operations in cold climatic conditions. In this work, we have calculated the coefficient of performance (COP) for a heat pump cycle in the extreme temperatures conditions such as observed in an arctic environment. For the study, climatic data from Karasjok (69°28' 55'' N 25°6' 18''E) is used as a test case (eKLIMA, 2014). Karasjok is located in Finnmark county of Norway. The refrigerants included in this study are R134a (Tetrafluoroethane), R22 (variants of Chlorofluoropropane), R290 (Propane), R404a (mixture of R125, R143a and R134a), R410a (mixture of R34 and R125), R717 (Ammonia) and R744 (Carbondioxide). The evaluated heat pump is based on single stage process that includes a compressor, a heat exchanger, an expansion valve and a condenser. For the study, adiabatic efficiency of compressor is varied between 70-90 %. For heat exchanger and condenser a temperature difference of minimum 5 oC from surroundings is considered for their effective performances. For refrigerant such as R744, transcritical process is considered for the evaluation of COP. Analysis is performed in MATLAB® using the data for refrigerants from ASHRAE (CoolProp MATLAB® system libraries). In addition to the performance evaluations, a summary of other important selection factors including environmental concerns is presented. Conclusions are drawn based on the COP values from refrigerants for the heat pump operations.

Keywords: Multiphysics, Heat Pump, Cold Climate, Refrigerants

DESIGN OF A SNOW SLEDGE USING MULTIPHYSICS ANALYSIS

Corresponding Author
H. Khawaja
hassan.a.khawaja@uit.no

Authors and Affiliations
H. Xue, G. Mauseth, Narvik University College, Narvik, Norway
H. Khawaja, The Arctic University of Norway, Tromsø, Norway

Sledding is a worldwide winter activity, exercised most often in a prone or seated position requiring a device or vehicle generically known as a sledge or toboggan. There are few types of sleds commonly used today such as runner sleds, toboggans, disks, tubes and backcountry sleds. Each type has advantages and disadvantages with different slopes. The objective here is to design and optimise a snow sledge using Multiphysics tools for the shape and weight. Further to the design, part manufacturability is also included in the study where appropriate material is selected based on the evaluation. In this work, various geometric models are fabricated using Solidworks® CAD Package. Special attention is given in the design of damping and steering mechanism of the snow sledge. MATLAB® Simulink was used to study the dynamic response of the damping and steering system. The SolidWorks® 2014 plastic moulding module is used to simulate the manufacturing process. In this simulation, material for the part is fed into a heated barrel and forced into a mould cavity, where it cools and hardens to the shape of the cavity. It is found that one of the key factors in the study is the thickness of the part. Efforts are being made to optimize the geometry to reduce the thickness without affecting structure of the parts.

Keywords: Multiphysics, CAD, 3D Geometric Modelling, Injection Moulding

INFRARED DETECTION FOR ANTI-ICING SYSTEMS IN SHIP OPERATIONS

Corresponding Author
H. Khawaja
hassan.a.khawaja@uit.no

Authors and Affiliations
T. Rashid, H. Khawaja, Kåre Edvardsen, Department of Engineering and Safety, The Arctic University of Norway, Tromsø, Norway

The study is primarily based on the utilization of infrared sensing technique as an effective tool towards icing detection. The Infrared spectrum from 7µm to 12µm range is area of interest towards the particular observations and detection. Since temperature ranges of marine operations may vary but the study is focused towards the arctic marine operations in low atmospheric temperatures (as low as -30ºC). The infrared detection mainly relies on the emissivity of the material object. The typical ranges of ice and snow inclusive are experimentally known to be lying within 0.82 to 0.9. Smooth and rough ice is being close to 0.966 and 0.985; fine and granular snow close to 0.82 and 0.89 subsequently. The icing caused by sea spray can play major role in emissivity variation which can impact the reflectivity and absorption of the ice accretion over the ship deck and largely affected areas of the ship. The thermal gradient in correlation with change in emissive values under certain circumstances can be visualized and analysed with advanced forward looking infrared cameras available till date. The ice accretion and meltdown phenomena can be recursively observed to analyse the change in temperature and emissive values. The challenges will involve dealing with the variable emissive nature under different environmental conditions involving the brightness, temperature variation and sea spray cumulative influence towards ice accretion. The resulting analysis could assist to get insight into the ice accretion layout and rough ice thickness estimation. The study discusses the use of infrared techniques to solve energy efficient and cost effective anti-icing challenges faced in petroleum industry during exploration in arctic and Barents Sea.

Keywords: Infrared, emissivity, ice accretion, anti-icing

LINEAR DESCRIPTION OF THE NONLINEAR REALITY

Corresponding Author
R. Wojnar
rwojnar@ippt.gov.pl

Authors and Affiliations
R. Wojnar, Polish Academy of Sciences, Warszawa, Poland

The interplay between linear and nonlinear description of the physical reality on the level of quantum mechanics is considered. The complex-valued wave function Ψ of a particle satisfies linear Schrödinger's equation, but the physical meaning belongs to the complex square Ψ Ψ*. If the function Ψ is written in the exponential form (Bohm's representation), its both factors have the physical meaning. The amplitude r is simply the root square of the probability density of finding the particle, and the exponent η is a potential for the particle velocity. Equations satisfied by r and η are real-valued but non-linear. After averaging they give again linear equations of the classical mechanics, according to Ehrenfest's theorems. SCHRÖDINGER'S EQUATION: The most exact description of the real world is given by the wave function Ψ being the function of positions of particles and the time t. The function Ψ is determined by Schrödinger's equation, which is a linear equation. BOHM'S REPRESENTATION: The function Ψ is a complex valued function. In its exponential form, $\Psi = r \exp(i\ \eta)$, it has the amplitude r and the phase η. The square of r means the probability density ρ of finding of a system of particles in a given position, while the phase η is a potential for the velocities of the particles. Functions r and η satisfy a set of two nonlinear equations. We prove the equivalence of the last nonlinear system and of Schrödinger's equation, what means that the solution of the nonlinear system can be achieved by solution of the linear of Schrödinger's equation. The last system can be transformed into a system in which the density ρ and the velocity v appear explicitly. The first equation of this system presents a quantum version of the second law of the classical mechanics, while the second one is a typical continuity equation analogous to that of classical hydrodynamics. Also the equivalence of this system and of Schrödinger's equation can be proved.

Keywords: Schrödinger's equation, Bohm's representation, density, phase, velocity potential

RADAR IMAGE FELTRING APPROACH BASED ON THE CO-OCCURRENCE MATRIX

Corresponding Author
Raaf Ouarda
rf_ouarda@yahoo.fr

Authors and Affiliations
O. Raaf and A. E. H. Adane, France

Weather radars provide raw information for users to be interpreted for forecast of rainy cloud cells movements. A set of rules exist to recognize the signature of each type of precipitation. These are based on the study of similar cases and that the user must be familiar with these signatures. However, radar images are often contaminated with unwanted echoes from the ground. The latter are due to the reflection of the radar signal off the mountains, hills and buildings that are in radar's field of view. The purpose of this study is to remove the cluster from the ground echoes without changing the structure of rainfall from the radar image. To do this, we use 512 x 512 pixels images acquired every 5 min by a weather radar located in Bordeaux (France). Hence, we have applied a filtering method based on the calculation of the parameters of the co-occurrence matrix of Haralick on the above mentioned images The obtained results are satisfactory as most unwanted echoes were successfully eliminated keeping rain echoes almost unchanged. However, the images obtained with the correlation parameter are seen to be better since the resulting images slightly differ from the image without ground clutter.

Keywords: Radar images, Filtering, Co-occurrence matrix, Rainfull

THEORETICAL AND ANALYTICAL STUDY OF BEHAVIOUR OF WAVE PROPAGATING THROUGH HOMOGENEOUS COPPER SULPHIDE THIN FILM

Corresponding Author

Emmanuel Ifeanyi Ugwu

ugwuei@yahoo.com

Authors and Affiliations

Emmanuel Ifeanyi Ugwu, Dept. of Industrial Physics, EBSU,P.M.B. 53, Abakaliki, Nigeria

Metal chalcogenide thin films, like metal sulfide, metal selenides, and metal tellurides, possess useful electrical and optical properties and can be found in many technical applications. As a result of the applicability of these sulphide based thin film such as Indium disulphide and other sulfide based materials especially in photovoltaic cell and opto-electronic devices and based on that, scientists have geared their attention towards the development and study of the optical/ the solid state properties of such thin films materials both experimentally and theoretically. Having known this, there has also been intent to study the behaviour of electromagnetic wave propagating through homogenous copper sulphide thin film. In the case of this analysis, wave equation was solved using the method of separation of variable, in which we assumed the wave to be propagating along the homogeneous sulphide based thin film medium. Some parameters such as dielectric constant, permittivity of the material were specified in the solution of the propagated wave as regards the way and manner in which the film medium affects the behaviour of field propagated through the thin film with respect to position, U(x, t) for different propagation distance was analyzed in conjunction with ultraviolet, Visible and infrared regions .f electromagnetic wave spectrum .From the solution of the same equation we obtained the value for the absorption relation which was in turn used for the computation of the energy band gap of the thin film. The computed band gap is 2.583eV as against 2.00eVto 3.00eV obtained from experimental characterization using different growth method such as SILAR and CBD.

Keywords: Thin Film, Wave propagation, Dielectric constant, Electromagnetic wave spectrum, energy band gap

A GENETIC ALGORITHM APPROACH FOR ESTIMATING PROCESSES DERIVATIVES IN ON-LINE OPTIMIZATION

Corresponding Author
Moufid Mansour
m.mansour@city.ac.uk

Authors and Affiliations
Moufid Mansour AND Ali Affak, UK

Estimating process derivatives in the on-line optimization problem has been addressed extensively in last few years. In fact, it has received much attention due to the fact that earlier methods have encountered some major drawbacks in the past. This paper investigates a new method based on Genetic Algorithms (GA's) for estimating these derivatives within the well-known Integrated System Optimization and parameter Estimation (ISOPE) algorithm. It is shown using simulations on a Continuous Stirred Tank Reactor (CSTR) system how GA's can successfully estimate the derivative information and lead the ISOPE algorithm to converge to the right optimum point.

Keywords: On-line optimization, ISOPE, Genetic Algorithm, identification, parameter estimation, processes derivative

VULNERABILITY ASSESSMENT OF RC BUILDINGS

Corresponding Author
F. Imene. Belheouane
fimenebb@yahoo.fr

Authors and Affiliations
F. Imene. Belheouane, University of blida, Algeria

Seismic vulnerability assessment of reinforced concrete (RC) existing structures can be performed through the use of reliable tools this is in order to reduce damages in case of an earthquake event. Within this study, major parameters that have an influence on the seismic behaviour of RC buildings are identified. These parameters were defined by a static study of seismic data obtained after Ain Timouchent earthquake in 1999 and Boumerdes earthquake in 2003. The weighting factors for the three considered vulnerability classes of each parameter are also defined by seismic feedback experience and by modeling approach. A vulnerability Index (VI) is then calculated allowing the classification of the studied structure according a developed scale. Based on historic earthquakes and damages feedback of reinforced concrete structured in Algeria, the DPM (Damage Probability Matrices) are elaborated. A continuous formulation of these matrices enables the determination of semi empirical vulnerability curves. A program called PV (Program of vulnerability) is elaborated in Delphi. This program contains two modules: PVC (Program of Vulnerability curves) and VIP (Vulnerability Index Program). The first one gives the mean damage ratio of a structure and the second classifies the structure according its seismic vulnerability.

Keywords: Vulnerability index, earthquake, reinforced concrete, structures, damage probability matrices, vulnerability curves

SESSION 2.1

ADVANCES IN MATHEMATICAL MODELLING TECHNIQUES

FRIDAY 12 DECEMBER 2014
09:30 – 11:00

CHAIR

L. Dechevski
Narvik University College
Norway

SUPERCRITICAL AND CRITICAL CASES FOR 2D AND 3D BVP FOR QUASI-LINEAR EQUATIONS OF MIXED ELLIPTIC-HYPERBOLIC TYPE

Corresponding Author
Nedyu Popivanov
nedyu@fmi.uni-sofia.bg

Authors and Affiliations
Nedyu Popivanov, Faculty of Mathematics and Informatics, University of Sofia, Bulgaria

Starting from the ground-breaking paper of Pohozhaev (1965), it is well known that the homogeneous Dirichlet problem for semilinear elliptic equations such as $\Delta u+u|u|p-2 =0$ in Ω, a bounded subset of Rn, with n>2, permits only the trivial solution if the domain is star-shaped, the solution is sufficiently regular, and p>2*(n):=2n/(n-2), where the latter quantity is the critical exponent in the Sobolev embedding of H^{0}_{1}(Ω) into Lp(Ω) for p<2*(n). It has been shown in [1], [2] that the nonexistence principle in supercritical case also holds for certain two dimensional problems for the mixed elliptic-hyperbolic Gellersted operator L (instead of Δ), with some appropriate boundary conditions. It is also valid for a large class of such problems even in higher dimensions [3].

In dimension 2, such operators have a long-standing connection with transonic fluid flow. Of course, the critical Sobolev embedding in this case is from of a suitably weighted version of H^{0}_{1}(Ω) into Lp(Ω). As usual, in BVP for such mixed elliptic-hyperbolic Gellersted operator L, the boundary data's are given only on the proper subset of the boundary. To compensate the lack of a boundary condition on a part of boundary, a sharp Hardy-Sobolev inequality is used, as was first done in [1], [2], [3].

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Keywords: Pohozhaev identities, critical Sobolev embedding exponent, elliptic-hyperbolic operator

RECCURENT SEQUENSES IN SOLVING THE SCHRÖDINGER EQUATION

Corresponding Author
Alexander F. Polupanov
sashap@cplire.ru

Authors and Affiliations
A.F. Polupanov, Moscow State University of Psychology and Education, Moscow, Russia

An explicit numerical-analytical method is demonstrated for accurate solving the Schrödinger equation in those cases when it is reducible to a system of n coupled ordinary differential equations. The method is based on the matching of exact solutions, constructed as algebraic combinations of power series, power functions and logarithmic function in the neighbourhood of the regular singularity, and of asymptotic expansions of solutions in the neighbourhood of the irregular singularity. In the framework of the method it is necessary to calculate solutions and their derivatives only at a single intermediate point using derived recurrent relations for constant coefficients in power series and asymptotic expansions. It makes possible to solve accurately both the eigenvalue and the scattering problems and to derive analytical expressions for the wavefunctions. The method is applied to calculations of energies and wavefunctions of the discrete spectrum and wave functions of the continuous spectrum of the hydrogen-like atoms and of acceptors in semiconductors.

Keywords: numerical methods, ordinary differential equations, singular points, recurrent relations, eigenvalue problem, scattering problem

SURFACE HOLE MODELING USING BLENDING SPLINES

Corresponding Author

Aleksander Pedersen

aleksanderpedersen90@gmail.com

Authors and Affiliations

Aleksander Pedersen, Jostein Bratlie and Rune Dalmo: Narvik University College, Norway

Terminal ballistics describes the concept of how a projectile behaves when reaching a target where the energy transfer onto the target depends on the properties of the projectile. Perforation is one of the possible outcomes from terminal ballistics. Generalized Expo-Rational B-Splines (GERBS) is a blending type spline construction where local functions associated with each knot are blended by \$C^k\$-smooth basis functions. Modeling perforated surfaces can be achieved by using certain features and properties of the blending type spline construction, such as manipulation and insertion of multiple knots.We are investigating how to model perforated surfaces using the above mentioned blending type spline construction and utilizing its editability. Protection from projectiles, such as armor and protective plates for vehicles, buildings and more are application areas which can be explored in future simulations utilizing iso-geometric analysis.

Keywords: Blending splines, GERBS, terminal ballistics, perforation

INFINITELY SMOOTH GERBS-BASED PARTITION-OF-UNITY METHODS AS INTRINSIC TOOL OF ISO-GEOMETRIC ANALYSIS ON GENERAL SPLITS AND COVERS OF MULTIDIMENSIONAL DOMAINS

Corresponding Author
L. Dechevski
LubomirT.Dechevski@hin.no

Authors and Affiliations
L. Dechevski, Narvik University College, Norway

The purpose of this communication is to provide for a systematized exposition of the hierarchy of new constructions of Partition of Unity Methods (PUM) based on infinitely-smooth Generalized Expo-rational B-splines (GERBS) on general splits or overlapping covers of n-dimensional domains, n=2,3,..., with the important additional option of Hermite interpolation (or fitting with optimal criteria possibly involving derivatives) on scattered-point sets consistent with the respective domain splits or covers. 1. At the basis of this hierarchy is the general construction introduced in [1] (typically, using either tensor-product or radial intermediate bases, but more general shapes of the supports of the intermediate bases is also possible). In the present study a new element of this construction will be discussed, namely, how to incorporate boundary conditions which are either (i) of fitting type, using a penalization strategy typical for meshless finite element methods (FEM), or (ii) of interpolatory type, typical for FEM involving meshes, but with specifics designed to cope with the great generality of the construction. 2. Specialization of the construction for simplicializations of n-dimensional polygonal domains (triangulations in the 2-dimensional case, tetrahedralizations in the 3-dimensional case, etc.) with improved properties of the basis function in the PUM (supports reduced to the respective star_1-neighbourhoods of the vertices in the simplicialization). (a) Constructions specialized for 2-dimensional triangulated polygonal domains. (a1) The construction introduced in [3]; (a2) Two constructions based on local inversions of Christoffel-Schwarz transformations (b) Constructions for simplicializations for every n=2,3,.... (b1) A modification of the construction in [3], with a modification of the definition of an edge function in [3] such that it is possible to generalize it for all n=2,3,...; this will be followed by the respective new results for a volume, face, edge and vertex function in 3D. (b2) A recursive (in the dimension n) construction via detailed elaboration of ideas outlined in [2]. 3. Generalization of the constructions in item 2 to n-dimensional convex-tile splits such as, e.g., Dirichlet tesselations (Voronoi diagrams in 2D). Two common features for all of these constructions are that (i) underlying for each one of them are univariate univariate-smooth GERBS, and (ii) each one of them has a rational form which constitutes an upgrade of NURBS.

SESSION 2.2

DEVELOPMENTS IN MULTIPHYSICS METHODOLOGIES

FRIDAY 12 DECEMBER 2014
11:30 – 13:00

CHAIR

E. A. Al-Bahkali
King Saud University
Saudi Arabia

MULTIPHYSICAL APPROACH IN DEVELOPMENT OF MODELS OF DEFORMATION AND FRACTURE OF POLYMERS

Corresponding Author
L.A. Merzhievsky
merzh@hydro.nsc.ru

Authors and Affiliations
L.A. Merzhievsky, Lavrentyev Institute of Hydrodynamics, Novosibirsk, Russia

In the process of deformation under external loading polymeric materials show the complicated behavior connected with features of their structure. These features are shown in variety of mechanisms the deformation which are realizing at different structural levels. For amorphous polymers distinguish three physical state – vitreous, viscoelastic and plastic. To each of the listed states corresponds the its micro, meso - and macrostructural mechanisms of irreversible deformation. At deformation the mechanisms of deformation connected not only with flexibility of macromolecules and conformational transitions, but also with movements and reorganizations of supramolecular structures are consistently activated.In this report results of development of models for the describing of the polymers which are based on Maxwell's ideas of mechanisms of irreversible deformation are presented. The full system of the equations of model includes laws of conservation, the equations describing evolution of components of a tensor of finite strains and constitutive equations in the form of dependences of specific internal energy and time of a relaxation of shear stresses from parameters, characterizing a state of medium. At construction of constitutive equations multiphysical approach is used. Laws of nonequilibrium thermodynamics, mechanics of continuous environments, the description of kinetics of microstructural mechanisms of irreversible deformation are used. For the accounting of fractality of a structure of polymers the derivatives and integrals of a fractional order are used. On the formulated models stress-strain diagrams are calculated, a number of problems are solved. Results of calculations with the relevant experimental data are compared.
Work is supported by the Integration project of the Siberian Branch of the Russian Academy of Science No. 64 and a grant of the Russian Foundation for Basic Research No. 12-01-00726 -a.

Keywords: multiphysical approach, model, polymer, constitutive equation

SYSTEM DYNAMIC MODELLING APPROACH FOR RESOLVING THE THERMO-CHEMISTRY OF WOOD GASIFICATION PROCESSES

Corresponding Author

Gernot Boiger

boig@zhaw.ch

Authors and Affiliations

G. Boiger, ICP Institute of Computational Physics, Zurich University of Applied Sciences, Switzerland

For Multiphysics problems that require a thorough understanding of multiple, influential, highly transient process parameter dependencies, a system dynamic model can constitute either an alternative option, or a compact prelude to a more expensive 3-D Finite Element or Finite Volume model. As a rather uncommon example for the application of such a modelling method, this work presents a system dynamic modelling concept, devised for resolving the thermo-chemistry within a wood gasification reactor. It compares the modelling concept as well as its results to a classic, thermo-chemical solution algorithm based on the minimization of LaGrangian Multipliers and an iterative solution concept for resolving the gasification equilibrium equations. The system-solution is bound to the Arrhenius kinetics of on-going wood pyrolysis and molecular mass transfer effects to and from the gasification reaction zone. Thus the solver can predict the transient production rates of methane, hydrogen, carbon (di-)oxide and water as well as the residual amounts of pyrolysis gas and oxygen which occur during the gasification of a wood particle.

Keywords: system dynamic model, thermo chemistry, gasification, pyrolysis, modelling

AN IMPROVED MODEL FOR ESTIMATING FRACTAL STRUCTURE OF SILICA NANO-AGGLOMERATES IN A VIBRO-FLUIDIZED BED

Corresponding Author
Navid Mostoufi
mostoufi@ut.ac.ir

Authors and Affiliations
N. Mostoufi, College of Engineering, University of Tehran, Tehran, Iran

A study was conducted to determine the effect of operating conditions on the fractal structure of silica (SiO2) nanoparticle agglomerates in a vibro-fluidized bed. Several factors influence the performance of this process which include frequency and intensity of vibration. An improved model was proposed by assimilation of fractal theory, Richardson-Zaki equation and mass balance. This model can predict the main properties of nanoparticle agglomerates such as fractal dimension and its size in the agglomerate particulate fluidization (APF) regime. It was found that increasing the vibration intensity leads to a slight reduction in the fractal dimension of agglomerates while it reduces the number of primary particles in the agglomerate significantly. It was also shown that the size of agglomerates changes in the same way as the fractal dimension with respect to the vibration intensity. Agglomerate size decreases with increasing vibration intensity and finally reaches a constant quantity at high intensities. Therefore, the nanoparticle fluidization quality is improved by increasing the vibration intensity since vibration breaks the agglomerates and reduces the cohesive forces. This study demonstrated that the fractal dimension of Silica nanoparticle agglomerate is in the range of 2.61 to 2.69 and the number of primary particles in the agglomerate is in the order of 10^10. The vibration frequency is more effective than its amplitude on agglomerate size reduction. Calculated minimum fluidization velocity by applying predicted agglomerate sizes are in good agreement with the experimental data. This study revealed that features of the agglomerate structure are insensitive to the value of the R-Z exponent. However, variations in the minimum fluidization velocity with respect to this parameter is remarkable with a deviation of 2.5% to 70%.

Keywords: Fluidization, Agglomerates, Fractal dimension, Nanoparticles, Vibration

SPH AND ALE METHODS FOR MEMBRANE INFLATION

Corresponding Author
Mhamed Souli
mhamed.souli@univ-lille1.fr

Authors and Affiliations
Essam Albahkali, Hisham Elkenani, King Saud University, Saudi Arabia
Mhamed Souli, University of Lille, France

Simulation of airbag and membrane deployment under pressurized gas problems becomes more and more the focus of computational engineering, where FEM (Finite element Methods) for structural mechanics and Finite Volume for CFD are dominant. New formulations have been developed for FSI applications using mesh free methods as SPH method, (Smooth Particle Hydrodynamic). Up to these days very little has been done to compare different methods and assess which one would be more suitable. For small deformation, FEM Lagrangian formulation can solve structure interface and material boundary accurately; the main limitation of the formulation is high mesh distortion for large deformation and moving structure. One of the commonly used approach to solve these problems is the ALE formulation, which has been used with success in the simulation of! FSI (Fluid Structure Interaction) with large structure motion such as sloshing fuel tank in automotive industry and bird impact in aeronautic industry. For some applications, including bird impact and high velocity impact problems, engineers have switched from ALE to SPH method to reduce CPU time and save memory allocation.

Keywords: Fluid Solid Interaction (FSI), Smooth Particle Hydrodynamic (SPH), Arbitrary Lagrangian Eulerian (ALE)

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