School of Mechanical & Mining Engineering
School of Chemical Engineering
Advanced Water Management Centre
School of Civil Engineering
School of Information Technology and Electrical Engineering

2011 UQ ENGINEERING POSTGRADUATE RESEARCH CONFERENCE

Monday June 6 – Hawken Engineering Building (50), University of Queensland, St Lucia Campus

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

WELCOME

Welcome to the inaugural Postgraduate Student Conference for the Schools of Mechanical & Mining Engineering; Civil Engineering; Chemical Engineering; Information Technology and Electrical Engineering (ITEE) and the Advanced Water Management Centre (AWMC).

This is the third year the University of Queensland (UQ) have hosted the conference, but this is the first time that all four engineering schools have been involved.

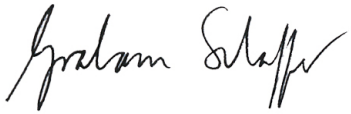
The Engineering Postgraduate conference provides post graduate students with the opportunity to present their research projects to academia and industry, improve presentation skills and network with potential employers and research partners.

There are limited opportunities for post graduate students to present research to peers in a conference setting, so this conference provides an important platform for students to share their work in the engineering community and learn from the experience.

The conference also presents a great opportunity for attendees to interact and gain an overview of post graduate research in the different engineering schools at UQ.

At the end of this meeting you will, most likely, have an enhanced appreciation of the many and varied research activities being undertaken across the broad fields of research in engineering at UQ. You may also feel some pride in belonging to a community that pursues excellence in research, promotes collaboration, openness, honesty, and respect, fosters integrity, and encourages creativity and innovation.

I anticipate you will enjoy this meeting and I hope it becomes an even more important part of your engineering calendar in years to come.



Professor Graham Schaffer
Executive Dean
Faculty of Engineering, Architecture, and Information Technology

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KEYNOTE SPEAKER

Dr John Wright BSC, PhD, FTSE, FAusIMM(CP), FAIE, FAICD

Dr John Wright has over 35 years experience in the energy and minerals processing sectors. He is currently the Principal of Wright Energy Consulting (WEC) specialising in the technical assessment of low emission technologies for the energy generation and supply industries. He was previously the Director of the CSIRO Energy Transformed Flagship Program, a position he held from 2002 to end 2008 and was the Chief of CSIRO Energy Technology from 1994 to 2002.

Recent activities include the Chair of the Independent Assessment Committee of the Smart Grid/Smart City Program, the Renewable Energy Development Fund (REDP) assessment committee, the Low Emissions Energy Development Fund Advisory Group of WA, the Solar Flagships Education Investment Fund (EIF) review committee, CRC interview panel and the current working group of the Prime Minister's Science, Engineering, Innovation Council – Challenges at the Energy/carbon/water Intersections.

Current Board memberships include Priority Research Centre for Energy (University of Newcastle) and the ZeGen (USA) Scientific Advisory Committee. Other committee memberships include the Implementation and Liaison Committee of the International Partnership for the Hydrogen Economy, the International Energy Agency's Hydrogen Implementation Agreement and Energy Science Expert Group.

Dr Wright is a Conjoint Professor at the University of Newcastle and a member of the Facility of Engineering Advisory Committee. He is a Fellow of; The Australian Academy of Technological Sciences and Engineering, the Australasian Institute of Mining and Metallurgy, the Australian Institute of Energy and the Australian Institute of Company Directors.

SESSION TIMES

Time	Program details/ venue			
8:50-9:00am	Conference welcome address **Venue: 50-T203**			
9.00-9.30am	Keynote speech by Dr. John Wright **Venue: 50-T203**			
Time	**Theme 1 Venue: 50-T203**	**Theme 2 Venue: 50-N201**	**Theme 3 Venue: 50-T103**	**Theme 4 Venue: 50-N202**
9.30-10.30am	Composites, Thin Films, and Biomedical Materials	Gas and Reaction Engineering, and Advanced Materials	Thermal Systems and Gas Dynamics	Water Management and Agriculture
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11.00am-12.45pm	Composites, Thin Films, and Biomedical Materials	Gas and Reaction Engineering, and Advanced Materials	Thermal Systems and Gas Dynamics	Water Management and Agriculture
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3.35-4.20p.m	Light Metals	Power Systems and Control Engineering	Biomedical and Data Engineering, Cyber Security	Mining, Transport, and Structures
4:20-4:35pm	**Break**			
4:40-5:00pm	Prize Awards and Closing **Venue: 50-T203**			
5:00-6:00pm	Conference Networking hosted by PRESS **Venue: Frank White Bldg (43) Entrance**			

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CONFERENCE PROGRAM

8.50-9.00: Conference welcome address		Venue:50-T203						
9.00-9.30: Keynote Speaker - Dr. John Wright								
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Theme 2: Gas and Reaction Engineering, and Advanced Materials 9.40-12.35, Venue: 50-N201	Dr Timothy Nicholson Dr Greg Birkett Associate Professor Rowan Truss
Theme 3: Thermal Systems & Gas Dynamics 9.40-12.35, Venue: 50-T103	Dr John Wright Dr Matthew Cleary Dr Kamel Hooman Dr Andrew Rowlands
Theme 4: Water Management and Agriculture 9.40-12.35, Venue: 50-N202	Associate Professor Damien Batstone Dr Chirag Mehta
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Theme 7: Biomedical and Data Engineering, Cyber Security 1.35-4.20, Venue: 50-T103	Dr Tudor Groza Dr David Mason Associate Professor Stephen Wilson Associate Professor Andrew Bradley
Theme 8: Mining, Transport, and Structures 1.35-4.20, Venue: 50-N202	Professor Ross McAree Dr Saiied Aminossadati Professor Paul Lever

CHAIRS

Theme 1: Composites, Thin Films, and Biomedical Materials 9.40-12.35, Venue: 50-T203	Hossein Khalilpasha Assisted by: Xiaogang Liu
Theme 2: Gas and Reaction Engineering, and Advanced Materials 9.40-12.35, Venue: 50-N201	Qiang Wang Assisted by: Vinita Nahar
Theme 3: Thermal Systems & Gas Dynamics 9.40-12.35, Venue: 50-T103	Jurij Karlovšek Assisted by: Nilesh Modi
Theme 4: Water Management and Agriculture 9.40-12.35, Venue: 50-N202	Sherri Hsu Assisted by: Dang Ho
Theme 5: Light Metals 1.35-4.20, Venue: 50-T203	Xiaogang Liu Assisted by: Qiang Wang
Theme 6: Power Systems and Control Engineering 1.35-4.20, Venue: 50-N201	Aleks Atrens
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Theme 8: Mining, Transport, and Structures 1.35-4.20, Venue: 50-N202	Carlos Ventura Assisted by: Rajinesh Singh

PARTICIPATING SCHOOLS AND CENTRES

SCHOOL OF CIVIL ENGINEERING

Civil Engineering at UQ performs research in six disciplines as listed below.
In each discipline, the research is to various degrees theoretical respectively applied and similarly very international versus locally inspired in different areas.

Conference advisory board: Associate Professor Peter Nielsen

DISCIPLINE AREAS:
- Structural engineering
- Environmental engineering
- Geotechnical engineering
- Transportation engineering
- Environmental Fluid Mechanics
- Coastal and Hydraulic Engineering

SCHOOL OF MECHANICAL & MINING ENGINEERING

The School of Mechanical and Mining Engineering conducts research to meet diverse and evolving needs of society. The School has established strengths in Light Metals, Mining Technology and Equipment, and Hypersonics. These are complimented by evolving strengths in composites, geothermal energy, metals, manufacturing and rock mechanics.

Conference advisory board:
Professor Ross McAree, Professor David St John, Professor Paul Lever, Associate Professor Rowan Truss and Associate Professor Han Huang

DISCIPLINE AREAS:
- Light Metals
- Polymers and Composites
- Rail Engineering
- Hypersonics
- Geothermal Energy
- Combustion and Coal Gasification
- Ultrasonics
- Mining Technology and Equipment
- Smart Machines

SCHOOL OF CHEMICAL ENGINEERING

The School of Chemical Engineering is a premier Australian research school and leads the world in a number of identified research strengths.
The School's researchers are constantly pushing the boundaries to achieve international research breakthroughs in a diverse range of areas including bioengineering, nanomaterials, high performance polymers, metallurgical engineering as well as waste and water resource management.
UQ chemical engineers work in partnership with many international institutions and companies, and have an impressive track record of technology transfer.

Conference advisory board:
Professor Peter Halley (Director of Research for the School of Chemical Engineering)
Dr Timothy Nicholson (Director of PG studies for the School of Chemical Engineering)

DISCIPLINE AREAS:
- Adsorption and Reaction Engineering
- Nanomaterial, Biomaterials and Polymers
- Food
- Water and Resource Management
- Energy and Environment Engineering
- Biological and Bimolecular Engineering
- Tissue Engineering and Microfluidics
- Hydrometallurgy and Pyro metallurgy
- Mineral Processing and Interfacial Processes

SCHOOL OF INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

The School of ITEE carries out research in all areas of Information and Communication Technology, combining academic excellence with social and industrial impact.

Conference advisory board:
Associate Professor Andrew Bradley (RHD Director, ITEE)

DISCIPLINE AREAS:
- Biomedical Engineering
- Cognitive System Engineering
- Complex & Intelligent Systems
- Data & Knowledge Engineering
- Microwave & Optical Communications
- Systems & Software Engineering
- Power & Energy Systems
- Security & Surveillance
- Ubiquitous Computing
- e-research

ADVANCED WATER MANAGEMENT CENTRE

The Advanced Water Management Centre (AWMC) is an internationally recognized centre of excellence in innovative water technology and management research. The AWMC thrives on both challenges and opportunities, and is embracing the changes, particularly in the urbane and industrial water context.
We have already a well established and highly successful research program in the sewer management area and the emerging reality of the sewer system becoming part of the overall water supply system will put more emphasis on the source management and control aspects in the urban sanitation system.
Given the concurrently growing recognition of the global climate change threat and the close link to the energy generation and utilisation, our existing activities on energy recovery from wastewater are also gaining momentum rapidly.
The AWMC strength is in the team of engineers, chemists and biomolecular scientists that lead multidisciplinary research programs. We are confident that we can maintain and further grow our strong credentials and we are keen to engage with the broader environmental industry over the coming year.

Conference advisory board:
Associate Professor Damien Batstone

DISCIPLINE AREAS:
- Sewer research
- Water recycling
- Anaerobic processes
- Nutrient removal and bio-products
- Greenhouse gases
- Microbial ecology
- (Bio) electrochemical systems
- Tissue Engineering and Microfluidics
- Hydrometallurgy and Pyro metallurgy
- Mineral Processing and Interfacial Processes

ABSTRACTS

THEME 1: COMPOSITES, THIN FILMS, AND BIOMEDICAL MATERIALS

1

Toughening and Reinforcement of Poly(vinylidene fluoride) Nanocomposites with "Bud-branched" Nanotubes

Xue-Gang Tang

Bud-branched nanotubes, fabricated by growing metal particles on the surface of multi-wall carbon nanotubes (MWCNTs), are used to prepare poly(vinylidene fluoride) (PVDF) based nanocomposites. Tensile tests show that the introduction of MWCNTs and bud-branched nanotubes increases the modulus. However, a dramatic decrease in the fracture toughness is observed for PVDF/MWCNTs nanocomposites. For PVDF/bud-branched nanotubes nanocomposites, a significant improvement in the fracture toughness is observed compared with PVDF/MWCNTs nanocomposites. Traditionally, to reinforce soft material by rigid fillers the cost for the improvement of the stiffness and strength is dramatic decrease of fracture toughness. This research shows a way to overcome that drawback.

2

Cracking the Mystery behind UV and Oxygen Degradable Polyethylene Films

Yu-Chieh (Sherri) Hsu

Our climate is changing and farmers are looking for new ways to grow produce to meet our needs. Farmers have been stretching clear polyethylene (PE) film (like cling-wrap) over the crop to create a little greenhouse. Doing this can save on irrigation, reduce pesticide use, and increase crop yield. However after the crops are harvested, PE films produce almost 1.3 million tonnes of landfill annually worldwide. A solution is to create a UV and oxygen degradable PE film, but the key challenge is timing the films to degrade when the crop needs to grow through. This varies based on crop type, weather, soil etc. There is still a gap in knowledge concerning factors affecting the PE degradation rate and what leads the film to become brittle and reach mechanical failure.

My studies show that the initial crystal structure plays a major role and the change in this leads to film failure. By understanding how various factors affect the film's degradation, we hope to tailor-make PE films suitable for various crops and farm sites.

3

A nanoscratch method for measuring hardness of thin films

Sheng Liu

Thin films were extensively used in the making of solar cells, cutting tools, magnetic recording devices, etc. As a result, the accurate measurement of mechanical properties of the thin films, such as hardness, was required. The thickness of thin films normally is very small. It is thus challenging to measure their mechanical properties. In this study, a nanoscratch method is proposed for hardness measurement. Three-dimensional finite element model is developed to validate the nanoscratch method and to understand the substrate effect during nanoscratch. The proposed method has demonstrated to be valuable for measuring hardness of thin solid films.

4

Understanding Moisture Diffusion Process in Oil-Impregnated Pressboard Insulation of Transformer

Raj Jadav

Moisture is one of the most influencing parameters, which accelerates solid insulation degradation and ageing process in transformers. Correct estimation of the moisture within solid insulation of transformer is still a challenge due to temperature driven complex moisture dynamics between oil and paper insulation. In this work moisture diffusion process in oil-impregnated pressboard samples is investigated at different temperatures to understand the moisture diffusion process of transformers.

A mathematical model for moisture diffusion is developed and numerical calculations are carried out using finite volume method. In our experiments, moisture diffusion process in oil-impregnated pressboard sample is investigated by continuous measurement of dissipation factor (Tan δ) at different temperatures. Finally, simulation results obtained from the moisture model are verified with experiment results.

5

Deformation Characteristics and Removal Mechanisms of Soft Brittle Solids

Rudy Irwan

This project investigates the surface characteristics of soft-brittle solids, such as HgCdTe compound. Soft-brittle materials are typically difficult to machine because the bonding between Hg and Te is very weak. Conventional machining will cause fracture on the surface and the subsurface, which will significantly affect the performance of the device. Nanomechanical testing is employed. Nanoindentation and nanoscratching on HgCdTe resulted in considerable plastic deformation, but no fracture features are observed. The hardness is consistent in various depths with average value of 500 MPa. The friction coefficient is significantly increased with increasing depth of penetration, ranging from 0.45 to 0.55.

6

Dynamic characterization of mechanical properties of ultrathin films

Shujun Ma

Thin films are important materials, which have found numerous applications in various fields. For structural uses, it is essential to gain detailed knowledge of their mechanical characteristics. However, the measurement of mechanical properties is challenging due to thin films' unique microstructures and special configurations. This PhD project aims to

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develop a dynamic testing methodology to measure elastic properties and residual stress in ultrathin films. The viability of the dynamic method was experimentally tested by measuring the elastic modulus of different samples. Particular attempts will be made to understand how the proposed methods can be used for ultrathin films.

7

Dysphagia: when eating can be a life threatening experience

Aarti Tobin

Dysphagia is a swallowing disorder prevalent in the elderly. Currently they are fed normal food that is either minced or pureed. These foods are difficult to measure 'fluids' because of the high concentration and large variation in the shape and size of the dispersed phase. We have used the vane tool to rheologically evaluate these foods, finding them to be characteristically solid-like with G'>G", but shear thinning above a critical yield stress and strain. The importance and relevance of these parameters on both texture perception and swallowing will be discussed.

Understanding the microstructure that controls the rheology of these foods will assist in developing novel foods that are easy and safe to swallow.

8

The shaft loaded blister test for the testing of thin film adhesion

Michael Heitzmann

A quantitative measurement of the adhesion strength of thin films to rigid fibre reinforced plastic (FRP) substrates is of great interest for many applications, in particular for the evaluation of coating systems. The blister test is a suitable test to determine the fracture toughness of interfaces between rigid substrates and thin films. The shaft loaded blister test in particular provides a series of advantages over other common adhesion tests. The presentation will discuss both experimental and theoretical aspects of the shaft loaded blister test. The main focus will be the research conducted to validate blister test results using analytical, numerical and experimental techniques.

9

Characterizing the interface between thermoplastics and thermoset epoxy composite materials

Luigi-Jules Vandi

The use of thermoplastics in combination with thermoset epoxy materials is becoming increasingly prominent in the aerospace industry, as surfacing material for carbon-fibre/epoxy components. The performance of the thermoplastic/CF-epoxy interface can be characterized by the depth of interdiffusion. However, microanalysis techniques used in until now have a very limited spatial resolution and cannot be used accurately for measuring interfaces smaller than 10μm.

This presentation examines the use of SEM-EDX and nanoindentation for characterizing thermoplastic/CF-epoxy interfaces. Spatial resolution limits are defined, and it is shown that increased resolution for this study is achieved, by operating at atypical acceleration voltages with SEM-EDX.

10

Effect of extrusion parameters on starch processing

Ming Li

The processing of starch is more complex than that of synthetic polymers due to its unique microstructures and multiphase transitions during processing. In this study, waxy (0% amylose) and high-amylose (~80% amylose) maize starches were processed by using a twin-screw extruder. Multiple regression analysis was performed on specific mechanical energy (SME) input with processing parameters, which were temperature, plasticizer content, screw speed, and feed rate. It was found that screw speed influenced SME input significantly for both starches. Temperature significantly influenced SME input during processing of waxy starch, while plasticizer content significantly affected that of high-amylose starch. Different starch behaves in substantially different ways when changing the processing parameters.

11

Effects of Bone Tissue Microstructure and Aging on the Micro-Mechanical Properties of Human Femoral Heads

Chih Ling (Jenny), Lin

Osteoporosis is a common, yet under-diagnosed, skeleton disorder, not only related to low bone mass, but also the disorganization of bone tissue microstructure and this contributes significantly to the failure of bone. This study utilized human cortical and trabecular bones from femoral heads, to examine effects of microstructure and donors age in terms of mechanical properties. Tissue mechanical properties were measured in three microstructures per sample by nanoindentation. Indentation modulus and hardness varied with microstructures. The interstitial lamellae had the greatest values of mechanical properties, while the trabecular had the least. The results demonstrate that mechanical properties are influenced by microstructures, rather than donors' age.

12

Microstructure and mechanical properties of Radio frequency (RF) sputtered diamond like carbon (DLC) coating on cemented carbide

Mingyuan LU

Cemented carbide has been accepted as high performance materials for tooling application. They are widely used in machining, mining and stone cutting industries. In order to prolong the tooling life, increase lubricity and improve the cutting efficiency, diamond like carbon coatings (DLC) are applied as protective layers on cemented carbide. However, direct deposition of DLC is usually restricted attributed to the strong catalytic effect of the binder metal (Co) in the

composite, which preferentially promote the formation of graphite and carbide contaminates. In this presentation, Radio Frequency (RF) sputtered DLC coatings deposited using different RF power are investigated for study the influence of the plasma power on the microstructure, phases composition and mechanical properties of DLC coatings.

THEME 2: GAS AND REACTION ENGINEERING, AND ADVANCED MATERIALS

13

Investigation of Gas Permeability in Carbon Nanotube (CNT)Polymer Matrix Membranes via Modifying CNTs with Functional Groups/Metals and Controlling Modification Location

Lei Ge

Metal- or functional group-modified multiwalled carbon nanotubes (CNTs) were embedded into the poly(ether sulfone) (PES) polymer matrix to study the gas permeability of the nanocomposite membranes. Carboxyl-functionalized CNTs and Ru (Fe) metal-modified CNTs were prepared via acid oxidation and wet impregnation methods, respectively. However, the CO2/N2 selectivity varies with different modification components. Compared with pure polymer membranes, those containing Ru-modified CNTs show higher gas selectivity, while Fe-modified CNT membranes show lower selectivity, and carboxyl CNT composite membranes are similar to pure PES membrane. By controlling Ru modification into CNT channels, poor gas selectivity of the corresponding membranes is observed. These results, combined with the results of density functional theory calculations, indicate that different gas adsorption behaviours are introduced via modification by metals or carboxyl functional groups and further influence the gas permeability. Thereby, tailoring modification on the external surface of carbon nanotubes can be more effective for improving gas separation performance of CNT-based nanocomposite membranes.

14

On The Hysteresis Loop of Argon Adsorption in Cylindrical Pores

Phuong Nguyen

We study the evolution of the hysteresis loop, its size and shape with the pore size, pore length and closed end by GCMC simulation. It is shown that the mechanism of condensation and evaporation is related to the fluid properties in the case of infinite cylindrical pores. In cylindrical pores of finite length, the hysteresis loop becomes smaller and then disappears when either the pore size or the pore length decreases according to the presence and movement of the fluid-vapour interface. We conclude that not only the pore size but also the pore length and the affinity of the closed end play important roles in determining the shape of the adsorption isotherm and should be taken into account in the characterization of pore structure from gas adsorption.

15

A comparison study of catalytic oxidation and acid oxidation to prepare carbon nanotubes for filling with Ru nanoparticles

Li Wang

Ru catalyst confined within the channels of multiwall carbon nanotubes (MWCNTs) is prepared by opening tube ends via mixed concentrated acid oxidation or catalytic oxidation, followed by filling via wet impregnation. The catalyst filling ratio is characterized by X-ray photoelectron spectroscopy (XPS) and transmission electron microscopy (TEM). The defects and functional groups are detected and quantified by Raman, fourier transformer infrared spectroscopy (FTIR) and XPS. The results show that high catalyst filling efficiency (~80 %) can be achieved with catalytic oxidation pre-treatment. The effects of the nanotube length distributions, defects and functional groups on filling efficiency have been discussed intensively, which can give us guidance on selective deposition of metal catalysts onto CNTs.

16

Study on the emissions from a CI engine combusting Dimethyl Ether (DME) as a diesel fuel alternative

George Thomas

Dimethyl Ether (DME) is considered as a promising alternative fuel for diesel. Australia has several potential sources to manufacture DME and these include coal, bio-wastes, carbonaceous materials, and CNG. Potential application of DME includes use in automobiles, as an alternative for or additive in LPG, as a propellant, and in remote power stations. The major project tasks are divided into; building an engine test cell for experimentation using DME in diesel engines, conducting studies on the NOx and particulate emissions from DME combustion, and developing CFD models for simulating DME combustion process and emissions from a common rail diesel engine.

17

In Vitro Biogenic Methanogenesis from Surat Basin Coal

Samuel Papendick

Microbial enhanced coalbed methane (MECoM) aims to enhance in-situ coal seam gas (CSG) production by stimulating a native or introduced coal-to-methane biodegrading microbial community. Several CSG formation waters collected from the Surat basin of Queensland tested positive for active microbial consortia with the ability to convert native Walloon coal to methane. Several culture screenings explored the coal degrading mechanism; active CO2 reducing methanogens confirm stable isotopic analysis and have implications for coal seam CO2 storage. Methane yields were proportional to coal particle size and enhanced with a non-ionic surfactant, emphasizing the importance of mass transfer and coal bioavailability in this coal-microbial system. The microbial preference to certain coal components is currently being explored.

18

Catalytic degradation of high density polyethylene (HDPE) in a reactive extruder

Sandeep Sarathy

Catalytic degradation of high density polyethylene (HDPE) using silica-alumina has been shown to be a technically viable option for the recycling of waste HDPE. Previous work in a thermogravimetric analyser has found activation energies of 256 kJ/mol and 174 kJ/mol respectively for thermal and catalytic modes of degradation acting in parallel.

This paper further investigates the kinetics with the aid of a 'lumped' model developed using the product distributions from a reactive extruder. This model allows the prediction of product distributions under varying catalytic loads and residence times. A comparison to commercial diesel and petrol (gasoline) is also shown.

19

Carbon Dioxide Sequestration by Aqueous Mineral Carbonation of Serpentine

Kimia Alizadehhesari

The dramatic increase in atmospheric carbon dioxide since the Industrial Revolution has caused concerns about global warming. The reaction of magnesium-rich minerals with CO_2 can eliminate the emission of CO_2 to the atmosphere. Barriers for development of mineral carbonation are energy intensity and high expenses. Indirect mineral carbonation by an ex-situ process in an aqueous system has been investigated in the present work. Serpentine [$Mg_3Si_2O_5(OH)_4$] as a mineral and carbon dioxide (CO_2) has been used to produce magnesite ($MgCO_3$) in a multi-stage process. Experiments were carried out on the ground serpentine. The slow natural geologic process that converts serpentine to magnesite can be accelerated by controlling the pH of the solution. The impact of pH control on mineralization has been studied by measuring the precipitation.

20

A novel pressure swing adsorption process for low-cost CO_2 separation at high temperature

Junjun Yin

The Carbon Adsorption Material (CAM) group at UQ proposed a novel pressure swing adsorption process which is operated at relatively high temperature (650-800°C) using the reversible reaction of calcium oxide with CO_2, i.e. $CaO+CO_2 \rightleftarrows CaCO_3$. The main innovation of this work is to regenerate sorbents by CO_2 partial pressure swing using the reaction heat released during the forward reaction so that the required external energy for sorbents regeneration is significantly reduced, which would in turn diminish the CO_2 capture cost by about 75%.

My current contributions focus on the development of the specifically designed calcium-based sorbents and the setup of a lab-scale tube furnace, which is used for the future testing of CAMs in realistic conditions and experiments data collection of single CAM particle for modelling work. This presentation shows the fundamental principles of the new process, the reasonable good performances of CAMs and their potential problems needed to overcome.

21

The Cyclic Voltammetry (CV) studies of the impregnated Fe/N into various carbon supports in 0.05M H_2SO_4

Rapidah Othman

The cyclic voltammetry (CV) studies of the impregnated iron in to carbon focusing on the influence of various carbons as catalyst supports for the oxygen reduction reaction (ORR) in Proton Electrolyte Membrane Fuel Cells. There are two different ways of treating the carbon supports before loading the iron via the wet impregnation method. The resulting composites are heated up by two different approaches; (1) In the presence of H_2/Ar at 500oC followed by passing an NH_3 gas at 700°C (2) In the presence of NH_3/H_2/Ar at 900°C simultaneously. The produced catalysts are characterized using Cyclic Voltammetry (CV) in a three-electrode electrochemical cell. There would be a reduction peak observed for an electrocatalytically active catalyst. The CVs have been done in 0.05 M H_2SO_4 saturated N_2 in the potential range between -0.25 V to 0.75 V. The results of this work have been discussed in the paper.

22

Effects of phenolic resin carbonization conditions on Carbon Molecular Sieve for Ethanol Dehydration

Yingjun Song

Carbon molecular sieves (CMSs) can be synthetised as membranes to effectively separate water-ethanol mixture by pervaporation, due to the molecular-sized pores and organophilic nature of carbon surface. A series of samples were prepared from a phenolic resin and characterized by thermo-gravimetric analysis (TGA), Fourier-transform infrared spectroscopy (FTIR) and nitrogen adsorption. Water vapor and ethanol vapor adsorption on carbon molecular sieves was also studied. The studies indicate that the carbon molecular sieves prepared at 600oC and 700oC are both highly microporous materials, with a correspondingly large surface area. BET surface area was observed to increase with increasing carbonization temperature but this also resulted in a decrease in the mean pore size. FTIR and TGA showed that most functional groups disappeared around 700oC. The sample carbonized at 700oC also showed the highest ethanol adsorption whilst the sample carbonised at 800oC showed highest ethanol/water adsorption ratio.

23

Rheology of Deformable Microgels in Suspension

Heather Shewan

Suspension rheology of deformable microgel particles is fascinating as simply by increasing microgel concentration their behaviour can change from Newtonian to shear thinning with an apparent yield stress. Microgel suspensions also act as an excellent model for more complex soft systems such as foods.

The rheological response of microgel suspensions is dependent on the particle rigidity (G_p), phase volume and interaction potential. A decrease in G_p results in an increase in maximum packing fraction (Φ_m) above that defined for hard spheres. Above Φ_m, bulk suspension behaviour is solid-like below the yield stress. When confined in a narrow gap solid-like behaviour is seen below Φ_m and we explore this in relation to G_p.

24

Ammoniacal Elution of Nickel and Cobalt from Ion Exchange Resin – New Options for Australian Laterite Ores

Patrick Littlejohn

Existing options for treating Australian lateritic ores rely on counter current decantation (CCD) to separate dissolved nickel and cobalt from unwanted impurities. The capital cost of CCD can be 30% of a several billion dollar laterite plant. Resin-in-pulp is an alternative to CCD where metal is collected by contacting leach slurry with ion exchange resin. Recovery of nickel and cobalt from resin traditionally uses unselective acidic eluents. Ammonia based eluents offer higher selectivity for nickel and cobalt and direct compatibility with existing ammonia based Australian refineries. In this work the technical feasibility of ammoniacal elution is demonstrated.

THEME 3: THERMAL SYSTEMS AND GAS DYNAMICS

25

Thermal Management in Hypersonic Vehicles

Fabian Zander

One of the greatest challenges of hypersonic flight is the management of the thermal loads that are experienced by the vehicle. To survive these conditions a design which can utilise active cooling, i.e. regenerative, ablative or transpiration cooling, as well as radiative cooling is required. This thesis investigates the use of high temperature structural materials to enable radiative removal of significant amounts of thermal energy from the system in combination with active techniques. Resolution of this design issue is critical for the design and development of future flight vehicles in the hypersonic regime.

26

Dynamic characteristics of a closed supercritical-CO_2 power-loop in a geothermal power plant

Rajinesh Singh

Power generation using heat from Hot-Dry Rock (HDR) geothermal resources in Australia has the potential to provide baseload electricity from a clean and indigenous energy source. The prospect of enabling the production of baseload electricity has prompted the need to reduce the costs of producing electricity from geothermal heat resources through the employment of a power-loop with a high net-output to investment ratio. This work investigates the transient behaviour and control of a closed Brayton-cycle power-loop using supercritical carbon-dioxide (S-CO_2) as the working-fluid. The development of a dynamic model for simulation of the time-dependent behaviour of the S-CO_2 power-loop is presented along with initial dynamic simulation results showing loop response during startup and heat addition, as well as during changes in cooling-medium temperature.

27

Development of High Total Pressure Scramjet Flow Conditions using the X2 Expansion Tube

David Gildfind

Current understanding of scramjets indicates that they may be able to provide air-breathing propulsion at flight speeds between Mach 5-15. Expansion tubes are currently the only facilities with the potential to duplicate the high total pressures (i.e. gigapascals) of air-breathing Mach 10-15 flight that are associated with access to space.

The University of Queensland is undertaking work to develop these very high total pressure flow conditions in the X2 expansion tube facility, with a view to scaling up these conditions to the larger, higher performance X3 facility in future. Preliminary results of the X2 flow condition study are presented, including 1-D and 2-D CFD analyses, and experimental results.

28

Convection Heat Transfer in Supercritical Pressures

Pourya Forooghi

Supercritical power plants are advantageous in terms of efficiency and power density. In supercritical pressures, there is no exact distinction between liquid and gas phases; instead, a sharp change of thermo-physical properties is observed when temperature is changing. This sudden change of properties causes heat transfer of supercritical fluids not to follow conventional correlations. Most importantly, there is a possibility of heat transfer impairment due to the effects of buoyancy and/or flow acceleration. Therefore, careful studies are necessary before design of thermal devices in such pressure ranges.

This presentation outlines main features of supercritical heat transfer and introduces some of the main challenges in their modelling.

29

An Investigation of Supersonic Impulse Turbines for Use in Supercritical Rankine Cycles Associated With Geothermal Power Production

Jason Paul Czapla

Thermodynamic cycle analyses indicate that Supercritical Rankine Cycles (SRC's) operating at high pressure ratios may yield superior efficiencies for geothermal binary power stations. Impulse turbines show promise in being able to operate efficiently at these high pressure ratios. Impulse turbines have been in use for many years and it is a mature technology, but they are typically associated with steam flow. However hydroflouorocarbons (HFC's) yield the best cycle performance for SRC's in geothermal application. Development of an efficient impulse turbine operating with HFC's as the working fluid in a SRC could greatly improve geothermal power plant operating efficiencies.

30

Preliminary Design and Performance Estimation of Radial Inflow Turbines

Carlos André de Miranda Ventura

A comprehensive preliminary design approach for radial inflow turbines is described in the present work. An original code was written in Python and although it is inspired by published methodologies as the starting point for the design process, it involves a novel approach with regards to the automatic selection of these machines for any given application. In addition, it allows an integration with thermodynamic cycle analysis and three-dimensional blade design codes.

In the present work, an in-depth analysis and subsequent implementation of relevant loss models as well as selection criteria for radial inflow turbines is addressed. Sample test cases are used for comparison with other software packages and results are discussed.

31

Re-entry Radiation Aerothermodynamics

Umar Sheikh

Safety factors of about 50% are used on re-entry vehicle heat shields due to a lack of understanding of the radiation aerothermodynamics. The bulk of the uncertainty stems from the vacuum ultra violet (VUV) region of the radiation spectrum which is the greatest contributor in the overall radiative heat flux during re-entry (believed to be approximately 50% of the total radiative flux). VUV radiation is hard to measure as it is strongly absorbed by air. My experiments will measure the VUV radiation emitted by a shock layer and absorbed in the surface to eliminate the uncertainty in radiation aerothermodynamic models so that the design of future heat shields may become more efficient.

32

Dynamic Modelling of the QGECE Portable Power Plant

Braden Twomey

One way of exploiting a geothermal heat resource is to pump brine down into the rocks, bring the heated brine to the surface and transfer the energy into a low temperature thermal power cycle. My thesis interest is the development of dynamic models of the thermal cycle in anticipation of the under-design Queensland Geothermal Energy Centre of Excellence (QGECE) portable power plant. A key component of such a cycle is the expander. Experiments were carried out to characterise the QGECE laboratory scroll expander, which revealed that the performance is highly sensitive to internal leakage, the volume ratio is correct within 12%, but the work output is not as expected, indicating the need for parameter refinement.

33

Measurement of radiative heat transfer to a Titan aerocapture scaled vehicle in expansion tubes

Hadas Porat

Expansion tunnels are used to simulate atmospheric entry conditions into Titan. New conditions for peak heat transfer at the stagnation point with 6.5km/s shock velocity were developed using in-house 1D cfd code. Radiative heat flux will be measured using emission spectroscopy and radiation gauges. Emission spectroscopy provides information about the radiating species in the shock layer, and radiation gauges measure radiative heat flux on the surface of the scaled capsule.

The aim is to improve the poor understanding and large uncertainties (in access of 30%) associated with the prediction of radiative heat flux at atmospheric entry. In a Titan entry radiative heating accounts for a large percentage of the total heat load. This is a result of the carbon content in Titan's atmosphere, and the formation of cyanogen. Cyanogen is expected to produce 99% of the radiation in the shock layer, and this will be verified by emission spectra recorded in the experiments.

The radiation gauges consist of thin film heat gauge sensor mounted behind a viewing window, separating convective heating from the measured radiative heating. An optical set up consisting a set of convex lenses will be used to calibrate the radiation gauges with a collimated LED (270W, 385nm).

34

CO_2-based geothermal: research highlights

Aleks David Atrens

Engineered Geothermal Systems (EGS) represent an opportunity to expand geothermal power worldwide. Conventional geothermal systems use water as a heat extraction fluid, and typically as a working fluid. EGS could use different heat extraction fluids, of which CO_2 is one possibility. CO_2 behaves in substantially different ways to H_2O when used in geothermal systems. Discussed here are a number of the research findings regarding

differing characteristics, such as cooling-temperature-dependence, dominance of wellbore flow, surface plant design, and the role of fluid losses. The understanding provided by this work will provide the foundation for further development of CO_2-based EGS.

35

Natural Draft Dry Cooling Towers for geothermal power plants in Australia: A-frame bundles

Mehryar Sakhaei

Natural Draft Dry Cooling Towers (NDDCT) are considered to be the most appropriate cooling systems in arid areas of potential Australian geothermal power plants. Arrangement of heat exchanger bundles determines the extent of cooling reduction due to cross winds.

Present methods of cooling tower analysis are based on complicated iterative calculations. A simplifying method of porous medium modelling of an A-frame heat exchanger bundle is introduced. Fluid flow and heat transfer problems around heat exchanger fins and tubes is modelled with transport in a porous medium of specified permeability and form drag coefficient. This method is applied in numerical analysis of tower performance under different ambient temperature and wind speed. Obtained results are found to be in close agreement with available experimental data from literature.

36

Use of Shallow Aquifers for cooling Geothermal Power Plants in Arid Areas

Hugh Russell

Geothermal energy sources have great potential to provide a new source of renewable, base load power in Australia. As many of the pilot geothermal projects are located in arid areas with high ambient temperatures, the rejection of waste heat from the plant by fan-forced air cooling is inefficient, in extreme conditions consuming 10% of a plant's power output. Shallow aquifers in these regions could supply an alternative source of cooling, with water from the aquifer being used directly to cool the plant's condensers and subsequently reinjected. The temperature increase in the reservoir could be counteracted during cool periods, when heat stored in the aquifer could be rejected to atmosphere.

THEME 4: WATER MANAGEMENT AND AGRICULTURE

37

Assessment of disinfection by-products during the production of High Quality Recycled Water

Katrin Doederer

In South East Queensland Advanced Water Treatment Plants (AWTP) produce high quality recycled water (HQRW) treating secondary effluent using monochloramine as disinfectant. When organic and inorganic substances in water react with disinfectants, disinfection by-products (DBPs), which are of concern due to their adverse effects on human health, are formed. Therefore, the understanding of DBPs and their formation is crucial for implementing their control. With liquid liquid extraction followed by analysis with vapour-phase chromatography, the type of DBPs formed and their fate across the treatment train of the AWTP could be investigated.

38

Molecular simulation of the first monolayer water molecules at non-polar solid surface with tuneable interaction strength

Hong Peng

The structure of the first monolayer liquid water at solid surfaces with contact angle ranged from super-hydrophobic (non-wetting, more than 140°) to hydrophilic (semi-wetting, ~65°) is investigated by Monte Carlo simulation. Both cosine value of contact angle and first maximum density are strong linear with interaction strength. It was shown that density distribution at super-hydrophobic surface did not show the oscillation behaviour. For the hydrophilic surface, the orientation distribution of water dipole at the peak of monolayer shows the two preference configurations in comparison with the single configuration at outmost of monolayer. The results could provide information on the transition behaviour of water molecules from non-wetting to semi-wetting.

39

Coupling DAMO and ANAMMOX processes in a membrane biofilm reactor for greenhouse gas neutral wastewater treatment

Ying Shi

The requirement of achieving high-levels of pollutant removal from wastewater with a minimized carbon footprint is a serious challenge in the water industry. A previous study showed that ANaerobic AMMonium OXidation (ANAMMOX) and Denitrifying Anaerobic Methane Oxidation (DAMO) microorganisms developed together in an enriched system. This work demonstrated that one-stage nitrogen and methane removal, requiring the simultaneous activity of ANAMMOX and DAMO microorganisms, can be obtained in spatially redox-stratified biofilm in a membrane biofilm reactor (MBfR). Our results indicated that ANAMMOX and DAMO microorganisms can develop a synergistic biofilm for the simultaneous removal of nitrate, nitrite, ammonium and methane.

40

Impact of water quality on membrane fouling in tertiary treatment for water recycling

Chrystelle Ayache

Municipal wastewater is a resource from which high quality water can be produced and recycled after tertiary treatment by membrane filtration. A better understanding of the effects of effluent quality on membrane fouling mechanisms is required to improve fouling prevention

and ensure optimum process operation. The aim of this work is to evaluate at pilot-scale the performance of reverse osmosis membranes for the treatment of secondary treated effluents from three different sites and to identify the compounds that could specifically contribute to membrane fouling. On the first site, specific analytical tools showed low concentrations of dissolved organics and nutrients in the secondary effluent and significant organic fouling was identified. The link between effluent composition and fouling type will be discussed.

41

A Simple Non-Cohesive Soil Pore Size Distribution Modelling

To Huu Duc

Internal erosion is assessed through the correlation between its Particle Size Distribution (PSD) and Pore constriction size distribution (PCSD). However their connection is still not clear and there are some difficulties of building PCSDs. The novel approach in modelling base on two assumptions: (1) all soil grains are spherical and (2) every particle leans on at least three other. To build a system of tetrahedrons by Soddy-Gosset theorem, authorial program CSD on VB try to fill alternately all particles from given PSD into a sample volume. The refill process occurs in a way to reach a predefined porosity of soil. The PCSD is calculated from characters of faces in tetrahedron system.

42

Understanding Micropollutants removal in Biological Activated Carbon Filters

Maxime Rattier

Much research effort is directed towards the investigation of alternatives to membrane processes for the production of purified recycled water. Biological activated carbon (BAC) filters combine both adsorption and biodegradation processes for the removal of bulk organic contaminants from wastewater effluents. However the mechanisms implied in the high removal of a variety of micropollutants such as pharmaceuticals and endocrine disrupting compounds are still largely unknown. Experiments in batch reactors showed that several organic compounds, which manifested resistance to biological transformation previously, were removed to high extent by the BAC. In the presence of sodium azide, the removal of several compounds often considered to be very well biodegradable were found to be significantly negatively impacted by the inhibition of the biomass. Similarly, the removal of two recalcitrant pharmaceuticals diclofenac and sulfamethoxazole, also decreased after the addition of the inhibitor. Biodegradation of the recalcitrant compounds by an acclimatized biomass is a plausible explanation for such systems. Further research will focus to elucidate the complex relationship between the presence of an adsorptive surface, the biodegradation capacity and the performance of BAC filters.

43

Simulating riparian dynamics in a groundwater-dependent ecosystem using a coupled vegetation and groundwater model

Yanzi Xiao

This study is to develop a model framework for a better understanding of the relationship between vegetation dynamics (in riparian zone) and groundwater availability in Bribie Island. Through regular monitor and measurement, the model can be applied to predict the vegetation change to the groundwater availability in order to assist managers with their decision making, which will lead to: establish a groundwater model (using Modflow) to understand the groundwater flow and water table changes in the study area; determine a vegetation response function to groundwater change and develop a vegetation model or module package to couple with the groundwater model.

44

Investigation of microbiologically induced concrete corrosion in Australian sewer networks

Barry Cayford

The corrosion of concrete sewer infrastructure is a significant problem that costs the Australian water industry hundreds of millions of dollars every year. In order to develop effective mitigation strategies, it is essential to characterize the microbial biofilm communities responsible and elucidate how their activities promote concrete corrosion. Corrosion associated sewer biofilm was collected from a main trunk gravity sewer site in Sydney and also from an access point in the Gold Coast sewer network. To assess the diversity of organisms present, DNA was extracted and high-throughput sequencing conducted. This cutting-edge technology revealed a much higher diversity of microorganisms than has been reported in previous studies. A comparison of environmental conditions and the microbe community revealed that despite large differences in the environment many organisms are common to both systems. These microbes are likely to be key to fully understanding the corrosion process.

45

Isotopic Fractionation of Fossil Carbon in Wastewater Treatment Plant

YingYu Law

Organic carbon (OC) constitutes a major fraction of the pollutants in sewage. As carbon compounds entering wastewater treatment plants (WWTP) are transformed and distributed via different pathways, the quantification of the fossil carbon fraction is essential to account for non-biogenic carbon dioxide emission. To achieve this, stable and radiocarbon isotope (13C and 14C) technique was trialled on wastewater samples for the first time. Preliminary results confirmed that approximately 8% of the carbon consists of fossil carbon. This study will be further expanded by studying two other WWTPs in Brisbane.

46

Temperature phased anaerobic digestion increases apparent hydrolysis rate for waste activated sludge

Huoqing Ge

Temperature phased anaerobic digestion (TPAD) is an increasingly popular method to improve stabilisation of waste activated sludge, which has poor degradability. However, there is little analysis to determine the nature of the pre-treatment process during TPAD. In this study, an experimental thermophilic-mesophilic TPAD was evaluated, and achieved 41% and 48% volatile solids destruction during pre-treatment of 60°C and 65°C, respectively, compared to 37% in the control mesophilic-mesophilic TPAD. Sludge solubilisation was also enhanced by thermophilic pre-treatment. Model based analysis indicated that the improved performance was due to the increased hydrolysis coefficient under thermophilic pre-treatment of 60°C-70°C over mesophilic pre-treatment.

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A novel method for analyzing microbial community structure of anaerobic granules

Yang Lu

Anaerobic granule is highly important for many industrial wastewater treatment systems. A better understanding of microbial community structure is needed and possibly provides more opportunity to manipulate granules effectively. A novel method to apply shear force to remove microbes selectively from the successive layers in an anaerobic granule has been described in this work. As a result, whole molecular analysis of anaerobic granules on layer bases can be achieved. Our results so far have indicated that granule layers can be successfully selectively sheared, and that the outer layer microbial population varies substantially, with distinct and dominant (mainly bacterial) populations varying substantially between brewery, cannery, and cheese/butter fed granules.

48

Dynamic dewetting of the sessile droplet on solid surfaces and its application in agriculture

Tuan Nguyen

Agrichemical products are delivered to the target crops most commonly by spray application. Dynamic dewetting of spray droplets during the evaporation is found significantly influences the distribution of active ingredients inside the droplet. Despite their importance, the immediate relevance to dynamic evaporation of spray droplets is uncertain and our current understanding of kinetic dewetting of spray droplets on leaf surfaces is rather incomplete.

In this research, the evaporation of sessile droplets on solid is theoretically analysis. Experiments are conducted on solid and leaf surfaces of different species to examine the role of these surface properties on evaporating sessile drops. Good agreements between the theoretical and experimental results were observed during pinning and depinning stages of evaporation.

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Interfacial structure between particles in an Al protective coating on Mg alloy

Qiang Wang

The high strength-to-weight ratio of Mg alloys has attracted increasing interest in the transportation industry for the purpose of vehicle weight reduction, directly leading to fuel efficiency and great contribution to reduce the Green House effect. However, their application has been significantly limited due to poor corrosion and wear resistance. To solve the problem, the present study produced a coating with enhanced performance, using a powder deposition technique Cold Spray, which uses high pressure gas to accelerate particles on the substrate. Particularly, the current focus is to understand the bonding mechanism between particles in an Al coating on Mg alloy.

50

A review on the machinability improvements of titanium alloys

Rizwan Abdul Rahman Rashid

Titanium is one of the world's most versatile materials with a plethora of manufacturing applications due to its unique combination of properties. But high production costs and low production volumes has restricted its use in a number of applications. In the area of titanium machining major productivity benefits have been demonstrated by researchers developing enhanced tool materials, improved cooling strategies and innovative laser assisted machining technologies.

The overall aim of the ongoing research studies in this field are to:

a) Achieve a much better understanding of the machining behavior of titanium alloys
b) Develop enhanced knowledge on the machinability characteristics of beta titanium alloys
c) Evaluate the potential of various modern machining technologies such as laser assisted machining and hybrid machining with titanium alloys

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Distortion in a sintered 7xxx aluminium alloy

Xini Yuan

This talk presents an experimental and numerical study on the effects of sample position and gas flow on the distortion of a sintered 7xxx aluminium alloy. The experimental study examines distortions of three equally spaced compacts during sintering by the observation of microstructural evolution. A computational fluid dynamics (CFD) model was developed to investigate the different gas behaviors under corresponding experimental conditions. Streamlines surrounding each sample were generated to assist the analysis of mechanism of distortion.

This study addresses the distortion of a 7xxx aluminium alloy caused by gas during sintering, which is essential to the dimensional control of parts during the industrial production.

52

The influence of Cu on eutectic nucleation and silicon morphology in hypoeutectic Al-Si alloys

A. Darlapudi

Experiments were carried out in binary Al-10 Si alloys in modified and unmodified conditions in order to investigate the influence of increased addition of copper on eutectic silicon morphology and nucleation. Samples were quenched to observe the evolution of microstructure during solidification. Addition of copper resulted in an increase in the nucleation frequency of eutectic cells. A change in silicon morphology was observed concurrently with the change in nucleation frequency. At high copper levels, in modified alloys, a change in the eutectic interface morphology from near-planar to coral-like was observed.

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Effect of composition on secondary dendrite arm spacing of Al-Si-Cu-Mg (Fe/Mn) alloys for a given cooling rate

Tharmalingam Sivarupan

Experiments were carried out to study the variation of secondary dendrite arm spacing (SDAS) of Al-Si-Cu-Mg-(Fe/Mn) alloys with the cooling rate and composition. Sand casting trials were carried out in Al-Si-Cu-Mg-(Fe/Mn) alloys with varying compositions of Si, Cu and Fe using an inverted mould. Alloys were prepared in an induction furnace at about 730ºC and triple-plate castings were cast using chills at the bottom of the plates for promoting directional solidification. Thermal information was acquired using pre-installed thermocouples through the mould wall. Optical microscopy studies were implemented to study the variation of secondary dendrite arm spacing (SDAS) as a function of chemical composition and cooling rate.

The relationships between cooling rate and SDAS were plotted for the alloys and SDAS decreased with an increase in cooling rate and also with the increase in alloy composition.

54

Oxidation Kinetics of Molten Aluminium

Stephen Bonner

Studies of aluminium oxidation have traditionally been done thermogravimetrically, a technique which is sensitive to the initial condition of the oxide. This has lead to significant variations in data reported in the literature, which makes industrial modelling problematic. A novel experimental technique has been developed to address this limitation. Experiments to measure oxide mass forming on an aluminium melt surface have been conducted in the temperature range 750-850°C for holding times of 0.5-10 minutes, and appear to follow a power law relationship. This data will be combined with microstructural characterisation of the oxide to develop a kinetic oxidation model.

55

Strain hardening behavior of high pressure die cast Mg-Al alloys

Kun Vanna Yang

A bimodal microstructure consisting of fine primary α-Mg and coarse externally solidified grains, and a skin layer with higher integrity and hardness were normally obtained in the cold chamber high pressure die cast (HPDC) Mg-Al alloys. The specimen's overall structual properties are determined by both the local bimodal microstructure distribution and the global scale characteristic of finer microstructure at the skin and coarse one at the core. The Kocks-Mecking method was applied for the analysis of 7 binary HPDC Mg-Al alloys with Al content varying from 0.5 to 12 wt. % to investigate the HPDC bars' overall strain hardening behaviors. The strain hardening rates of the dilute alloys matched that of pure Mg polycrystals, indicating that the cross section yielded uniformly. For the concentrated alloys very high strain hardening rates were observed at very low strains, which suggested that the core yielded first whereas the skin remained elastic. The Kocks-Mecking model also quantifies the volume fraction of skin which remains elastic, of ~35% for the Mg-12wt. % Al.

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Effect of Solute Content on the Pseudoelastic Behaviour of Mg-Al Alloys

Nagarajan Devarajan

The current research was aimed to study the pseudoelastic behaviour of Mg-Al alloys with varying levels of aluminium content. Sand casting trials were performed on three varying aluminium contents 0.5, 2 and 9at % using an electrical resistance furnace. Tension and compression tests using loading-unloading loops were carried out to find out the contribution/ activity of twinning to the macroscopic strain with increasing aluminium contents. The obtained results showed that the amount of pseudoelastic/ anelastic strain decreases with increasing aluminium content thereby decreasing the tension-compression asymmetry.

57

Thermal expansion of Cu_6Sn_5 and $(Cu,Ni)_6Sn_5$ in lead-free solder alloys and joints

Dekui Mu

Cu_6Sn_5 is an important intermetallic present in lead-free solder alloys and joints and undergoes an allotropic transformation from a high temperature hexagonal **η**-Cu_6Sn_5 to monoclinic **η**'-Cu_6Sn_5 at temperature below 186ºC. This research characterises the thermal expansion of both **η**'- and/or **η**-Cu_6Sn_5 and the dimensional changes that occur as a result of the allotropic transformation. Techniques used include dilatometery and Synchrotron powder X-ray diffraction. A volume shrinkage during the high temperature hexagonal to low temperature monoclinic transformation during cooling was clearly observed for Ni-free Cu_6Sn_5 but not for Ni containing $(Cu,Ni)_6Sn_5$. It is concluded that Ni will reduce undesirable thermal expansions by stabilizing the hexagonal Cu_6Sn_5 at temperatures below 186ºC as well as by reducing the overall magnitude of the thermal expansion of Cu_6Sn_5. The results have scientific and industrial relevance and will help to improve the reliability of soldered joints.

58

Voltage Stability Analysis of Unbalanced Power Systems due to High Photovoltaic Penetration

Ruifeng (Richard) Yan

Photovoltaic (PV) power is becoming less expensive every year, thus its growth is expected to be much greater in the near future. However, this tendency is becoming a concern for distribution utilities as PV power generation depends on weather conditions and is not as controllable as a traditional fossil fuel power plant. In a geographically small area, PV power support to the grid voltage can be lost within a short period due to cloud coverage, and this can cause voltage fluctuations. This study first shows the potential voltage stability problem caused by PV power swing, and then this issue is analysed using unbalanced analysis theory that has been developed by the author. Finally, possible solutions are proposed based on the theory.

59

Reliability and Cost-Benefit Analysis of Long Transmission System Connecting Remote Geothermal Power Sources to the NEM Network

Kazi Nazmul Hasan

This research addresses a number of influential economic and electrical-network-reliability issues for renewable geothermal power generation entry to the Australian National Electricity Market (NEM) considering an advanced probabilistic transmission expansion planning methodology. Uncertainty modelling of stochastic parameters involved with electrical network and electricity market will be the key contribution of this study. Incremental reliability improvement and net market benefit evaluation against investment will be quantified accordingly. The significance of this research will be its comprehensiveness and practicability for the 'Cooper Basin Geothermal' connection to the Australian NEM network. Results from this research are expected to improve the planning efficiency and reliability of the NEM network

60

Assessment of Low Frequency Oscillatory Stability of Power System with Large-scale Photovoltaic Power Generation and Energy Storage

Md.Rakibuzzaman Shah

Growing environmental concerns and attempts to reduce dependency on fossil fuels are bringing renewable energy resources to the bulk power grid. Among various renewable resources, solar PV is assumed to have the most favourable prospects. With high PV penetration, power system dominated by conventional generators will experience a change in dynamics and operational characteristics. Given this assertion, their effect on low frequency oscillatory stability issues no longer can be ignored. In this context, the main aim of the research is to address the low frequency oscillation problem of power system with high PV penetration and possible corrective measures.

61

Identification of the best location for Dynamic Reactive Power Compensator in Renewable Based Distribution System

Tareq Aziz

A number of ecological and cost-effective benefits have led large scale integration of renewable energy based distributed generation (DG) in existing power systems. Grid standards have been developed by network operators to invite this DG with certain set of regulations. Large DG units are facilitated with voltage control mode. But small DG units are restricted to operate with power factor control mode with minimal generation of reactive power resulting in slow voltage recovery. A new sensitivity index has been developed for placement of STATic COMpensator (STATCOM) in a large distribution system with number of dispersed small generations. The outcome of the analysis can be utilized to keep DG units remain interconnected with minimum number of STATCOM.

62

A New Composite Method for Assessing Market Power in a Congested Power System

Muhammad Bachtiar Nappu

Market power refers to the ability of generators in influencing energy prices above competitive level to obtain more profits. It may be the cause of transmission congestion that limits transfer capability in an interconnected area. Consequently cheap generators outside congested zone are prevented to supply their power, which makes energy prices higher. Hence independent system operators must be able to detect conditions in which market power has been or is being practised to guarantee a secure competition and economical operation of the electricity market. A new composite method for investigating market power by generators' bidding strategy under congestion circumstances is proposed in this presentation. Analysis on power market performance to identify potential generators to exercise market power is also scrutinised.

63

Enhancement of Stability of Emerging Distribution Networks through Smart Load Control

Sudarshan Dahal

The integration of smart devices into the electricity network has resulted in a structure that is more flexible, controllable and reliable. On the other hand, new issues and challenges are reported on stability of such networks. This work presents instability and control issue associated with low damped oscillation, which is caused by interactions among controllers and distributed generators. A robust load control concept has been proposed to enhance

damping. The proposed methodology disconnects some non critical loads of the system during system disturbances to improve stability. The effectiveness of proposed methodology has been tested on a 16- bus distribution network.

64

Power System Stability due to Long Distance Transmission

Huong-Mai Nguyen

Electricity from renewable sources has become an increasingly important contributor to the electrical energy system. The renewable sources, such as wind, solar and geothermal power, are normally located far away from the major load centres. Therefore, their integration to the power grid poses some serious technical problems. These problems in particular are more pronounced for the prospective geothermal power plants in Australia. The issues may range from controlling active power balance, providing adequate reactive power support, operation and types of interconnection used for transmitting the bulk power from a remote area to a major load centre. The project would address the question which interconnection option is technically more appropriate, given the specific Australian case, with existing power system control technologies.

65

Comparison of Modal Analysis and CPF Method in Determining Effective DG Placement for Voltage Stability Enhancement

Ardiaty Arief

Nowadays, the use of distributed generations (DGs) has grown rapidly because of its advantages due to the exhaustion fossil fuels and global warming problems. DGs can improve distribution system voltage stability also decrease electricity cost and lower emissions. However, proper placement of DGs plays an important role to maximise its benefits, therefore it has become a major challenge for power researchers. This study proposes a new DG placement method based on Modal Analysis. To assess the efficiency of the proposed method, a well-known technique, the CPF is used as comparison. The results show the proposed method is more effective to decide DGs placement.

66

Modelling and Analysing Deep Brain Signals

Kristian James Weegink

The Non Markov Parameter has been used to analyse time series recordings from deep brain structures. Results have shown, in contrast to previous work, that the right Subthalamic nucleus exhibits different behaviour under linguistic tests.

To understand the changes occurring models such as the filter point process are used to model the nerve cells of the Subthalamic nucleus. The spectral properties of the model are compared to the recordings to validate the models and understand the change in behaviour associated with the change in the Non Markov Parameter.

67

Stability Controller for a Small Scale Urban Unmanned Aircraft Using System on Chip (SoC) Architecture

Bazle Eizad

The aim of this research is to develop a suitable control system which will allow for unmanned aircraft operations in obstacle dense urban environments. The vehicle must have high manoeuvrability yet there is a need for the system to be robust and redundant for safety reasons. A quadrotor is chosen as the test vehicle for this research because of its high manoeuvrability and mechanical simplicity. A prototype control system and vehicle have been partially developed and tested as stable under both typical and atypical flight conditions. A SoC approach is chosen for implementation for its ability to easily integrate a combination of both high-level non-critical software control components and low-level high-speed custom hardware control components

The presentation will include custom hardware implementation of PID control system, videos of test flights and the data recorded in those flights showing the capabilities of the system.

THEME 7: BIOMEDICAL AND DATA ENGINEERING, CYBER SECURITY

68

Semantic Web Based Best Practice Guideline Collaboration for Real-Time Tailored Multi-Disciplinary Decision-Support

Lisa New

A prototype Semantic Web Collaboration Application with wider applicability to any research collaboration with the aim to optimise risk management is designed, implemented and analysed. The specific prototype is tested in emergency care units to measure its contribution to point-of-care clinical decision-support, in terms of statistical improvement in the time to reach care consensus; and the prevention of preventable morbidity and mortality.

The application uses an innovative problem-solution semantic framework to transparently link practice evidence to policy; aggregate scientific with observational findings per level of evidence; integrate ranked expert opinion regarding best practice; link live data; and automate risk alerts.

69

Work Integrated Learning: A Realistic Evaluation of KMUTT's Chemical Engineering Practice School

Saranya Thonglek

ChEPS is a 2-year Master's program which is based on work-integrated-learning principles in Thailand. The program produces chemical engineers possessing attributes industry requires through the integration of chemical engineering courses and real-life problems experienced through placement in industry. As part of a program review concentrating on student learning at placements, program effectiveness, and sustainability, Realistic Evaluation (Pawson & Tilley

1997) was used to evaluate the perspectives of key stakeholders – current students, alumni, university, placement sponsors and subsequent employers. Initial results which suggest that the key to effectiveness lies in the context in which the program is offered will be presented.

70

Efficient Detection of Emerging Cyber Bullying

Vinita Nahar

With the proliferation of social networking and gaming sites, cyber-bullying is becoming an important security concern which in the worst scenario results in suicidal attempts by the victims. However, there are no effective methods of identifying cyber-bullying messages and subsequently blocking them. This research aims to investigate effective machine learning techniques for early detection and prevention of such messages that are propagating throughout the World Wide Web and thereby diminishing associated implications by blocking off the online predators. The application is structured on chat-log dataset with time-stamp, user name and message content to study the emerging pattern of web-bullying activities.

71

Processing of 3D fluorescent confocal images to investigate NanopatchTM vaccine delivery and the diffusion properties of skin

Stefano Meliga

The NanopatchTM, a silicon array of micro-projections, permits pain-free and cost-effective transdermal vaccination. Molecular transport from the drug-coated projection tips to cells is of fundamental importance, reliant upon negotiating the unique diffusion properties of the multilayer composite structure of skin. We applied dye-coated Nanopatches to mice and monitored the time evolution of the fluorescent signal using confocal microscopy. Processing the 3D images with Matlab, we spatially mapped the diffusivity and found that it increases with depth. These crucial insights into skin diffusion characteristics will allow us to optimise the NanopatchTM design for maximum delivery using minimal dose and application time.

72

Capturing knowledge evolution and expertise in community-driven knowledge curation platforms

Hasti Ziaimatin

Acquiring and managing expertise profiles represents a major challenge in any organization. Current expertise profiling techniques rely on analysing large collections of static documents, such as publications, associated with individuals. However, with the emergence of the Web of Data, and the shift from static documents to evolving documents (sustained by micro-contributions), such document-centric techniques are no longer applicable. My research proposes a novel, domain-agnostic framework for expertise profiling in the context of evolving knowledge bases emerging from micro-contributions, by combining fine-grained provenance, Linked Data and collaboration networks, capturing temporality in expertise.

The results of this research will lead to more accurate expertise profiling and will enable the development, among other things, of innovative trust and performance metrics.

73

Decision support methods in community-driven knowledge curation platforms

Razan Paul

Skeletal dysplasias form a group of genetic diseases characterized by highly complex, heterogeneous and sparse data. Performing efficient and automated knowledge discovery in this domain poses serious challenges, one of the main issues being the lack of a proper formalization. Semantic Web technologies can, however, provide the appropriate means for encoding the knowledge and hence enable diverse forms of reasoning. My research topic revolves around developing decision support methods in the skeletal dysplasia domain (e.g., automated diagnosis or inferring key disease features from an existing pool of patients) via uncertainty reasoning and imprecise rules using Semantic Web data generated from the SKELETOME community-driven knowledge curation platform. The outcome of my research will enable clinicians and researchers to acquire a critical mass of structured knowledge that will sustain a better understanding of these bone diseases and foster the advances of the field.

74

Computer Assisted Breast Lesion Characterisation

Darryl McClymont

Breast cancer is the most common cancer among Australian women, accounting for a quarter of all cancer diagnoses. MRI has been shown to be a useful adjunct to x-ray mammography, particularly for younger women. Diffusion-weighted (DW) MRI, a relatively new technology, provides a new avenue for breast lesion characterisation when used in conjunction with the traditional dynamic contrast enhanced (DCE) MRI. By developing computer-assisted techniques, the analysis of breast DW-MRI data can be made more reproducible, in addition to reducing the workload on clinicians. This will contribute to making breast DW-MRI more widespread in clinical practice.

75

Semantic Annotation Services for 3D Models of Cultural Heritage Artefacts

Chih-Hao Yu

Increasing numbers of museums are using 3D-digitisation techniques to preserve cultural artefacts and to make their collections accessible via online galleries. However, as the number and size of Web-based 3D collections grows, the ability to search such collections becomes increasingly difficult. Providing fine-grained metadata for large-scale 3D collections is labour-intensive and expensive. Moreover search terms vary widely between museum experts and the public. This presentation will describe an innovative 3D tagging system that enables the public to tag 3D museum objects using either their own terms or terms from an

ontology/thesaurus (that incorporates the most popular tags over time). It describes how this approach offers the optimum balance between freedom and quality control whilst enhancing the discoverability of 3D objects from online collections.

76

Clinically-based MRI analysis of spine anatomies

Aleš Neubert

Magnetic resonance imaging (MRI) based computer aided diagnosis of spinal injuries and degeneration (disc prolapse or herniation, cartilage degeneration, osteoporosis) can aid many applications where precise segmentation of the spinal anatomy is beneficial. The aim of our research is to develop an automated system for accurate detection, segmentation and morphological assessment of vertebrae and intervertebral discs from MRI. The challenges include intrinsic anatomical factors (geometrically complex vertebrae, intimate interlocking of various bony and soft-tissue structures, intra- and inter-patient variations) as well as imaging artifacts. We have presented and validated a segmentation algorithm on a dataset of high-resolution scans of lumbar and thoracic spines.

77

A Semantic Annotation System for Interactive Timelines

Lianli Gao

Interactive timelines represent an important class of non-static Web resources. As such, there is increasing demand for the ability to attach annotations to events displayed via interactive timelines, to enhance the interpretation and discovery of temporal events. In this presentation, I will describe the ontology-based Semantic Dynamic Annotation (SDA) system that I have developed - which is capable of annotating temporal entities and their relationships via interactive timelines. I will also outline how annotations can be created, shared and retrieved via Simile timelines by incorporating Semantic Web and Web 2.0 technologies and by extending the Open Annotation Collaboration data model, which is designed to maximize the interoperability and sharing of annotations.

THEME 8: MINING, TRANSPORT, AND STRUCTURES

78

Utilisation of damage index to evaluate performance levels of reinforced concrete structures

Vui Cao Van

When a reinforced concrete structure is subjected to a load larger than its yielding load, it may experience a certain performance level and damage state. The extent of damage can be expressed using a damage index which ranges from 0 (no damage) to 1 (collapse). In this paper, a new damage index for reinforced concrete structures subjected to static load is proposed. This, together with Park & Ang (1985) damage index, is used to establish the relationship between damage indices and performance levels of structures which are defined in FEMA (ASCE, 2000).

79

Systems modelling of parallel conveyors in DHCC systems

Juan Londono

As mines get deeper it is essential to carry out pre-stripping operations at open cut coal mines to allow the existing draglines to operate effectively. Pre-stripping operations have been usually carried out by Shovel/Truck haulage fleets. However the proportion of truck and shovel operation increases the Equivalent Unit Cost per cubic meter. Therefore there is the interest to examine other economic alternatives to conventional Shovel/Truck operations.

This research project evaluates the feasibility of using parallel conveyors systems in Dragline/Hopper/Crusher/Conveyor systems – (DHCC). The study analyses the maintainability and reliability model for DHCC systems to determine its availability, utilization and productivity.

80

Hard rock cutting and excavation by roller discs

Mehdi Serati

This paper deals with stress analysis of two different designs of wedge roller mini disc cutters using MARC FEM software. First design comprises a steel shaft connected to a tungsten carbide (WC) disc, while the second one considers tungsten carbide as the constructive material for both parts. Results indicate that the maximum tensile and shear stresses in the shaft itself never reached the ultimate tensile and shear strength of the shaft materials. However, many overstressed zones of stress concentrations were appeared on the disc, indicating inadequacy of the steel material in a disc used for hard rock cutting.

81

Optimized Mission Planning for surface transforming in mining

Tommy Chen

Track-type tractors are used to move material, thereby transforming an existing terrain profile into some desired form. It is envisaged that track-type tractors used in mining will eventually be automated. The objective of my work is to determine an optimal mission plan for terrain transformation using a track-tractor. It is foreseen that the mission plan will constructed on a receding horizon. The reason is that a global plan is mostly too complex to compute. The conceived solution method will be the application of optimization theory. The philosophical position is that the problem can be cast in the form of a convex optimization problem.

82

Introducing a qualitative damage index for retrofitting management

Behrouz Behnam

It is a well-known fact that second to the devastating wars; natural disasters are the largest enemy of human kind. For instance, in 2010, more than 230,000 of Haitian people were killed only because of earthquake and more than one million people were injured or become homeless.

In addition to the damage caused by the earthquake itself, the post earthquake events resulting from the shock such as fire can create even a more significant damage than the earthquake itself. The problem can be worsened as a result of fire progression into the surrounding buildings. From a different point of view, when conflagration happens after earthquakes, fire brigades have difficulty in helping people trapped under the rubble, as controlling fire takes priority. Consequently, the number of casualties will increase dramatically.

These events show the importance of retrofitting management in urban area. In this paper and based on Delphi method, a way is introduced to estimate and then mitigate the effects of earthquake on residential buildings.

83

Determining Optimal Digging Sequences for Mining Excavators

Peter Beasley

This project explores the problem of systematically changing an environment using a mobile manipulator. The specific application considered is for automated excavation in truck-shovel surface mining operations. The key barriers to an effective solution to this problem are the curse of dimensionality and combinatoric complexity, which lead to intractability. A solution which uses wavelet transform techniques has been developed in order to allow a rapid solution of the problem. Simulations of the proposed digging algorithm have generated shovel paths through the environment and manipulation requirements to complete the task.

It is proposed that through automation of the operator's task, and in particular the consistent application of dig strategies, the efficiency of material extraction can be increased and thus costs reduced. It is also expected that by removing personnel from high risk areas, mine safety can be improved.

84

Propagation of Errors in Sensing for Surface Mining Automation

Matthew Green

Verification of vehicle-pose estimates is an integral part of safe autonomous operation in surface mining. These estimates are typically made from measurements that are subject to high degrees of environmental and process noise, with any errors in the estimation process leading to potentially catastrophic outcomes under automation.

The work presented explores the problem of a workspace which is characterized by multiple different coordinate frames, and with pose estimates from multiple different sensors, each with their own unique sources of error. A methodology for unifying all sources of system uncertainty under a common coordinate frame is presented, along with its applications for the pose verification process.

85

Is AS IEC 61508 appropriate for the automation of mining equipment?

Tyson Phillips

AS IEC 61508 is a seven part international standard that is intended to frame functional safety requirements to industry. The standard was introduced by the International Electrotechnical Commission in 1998 in response to accidents in the chemical processing industries, and has been adopted as an Australian Standard.

The Australian mining industry is on a relentless march towards automation of large equipment including excavators and haul trucks. There is a lack of clarity among equipment manufacturers, technology developers, and the end-user mining companies about how to develop and operate automated machinery.

This presentation will examine the key question: is the lifecycle methodology of AS IEC 61508 relevant to the automation of large mobile equipment in the mining industry. The talk will identify a series of key research questions that must be addressed to establish the relevance of the standard and its methodologies to successful realization of safe, effective automated mining technology.

86

GPR application in Tunnelling

Jurij Karlovšek

Given the recent advances in tunnelling technology, tunnels can be excavated in virtually all types of soil and rock and in any environment, but uncertainties still remain. One of the most important factors is the knowledge of the ground parameters and conditions through which the tunnel will be routed. Construction practices can lead to development of such defects in the form of cavities. In civil engineering it is crucial to detect these variations in material properties and to detect the presence of defects. However, as they are often hidden from view, these attributes may be difficult or impossible to target with traditional testing methods. For these reasons rapid geophysical methods, such as Ground Penetrating Radar (GPR), are increasingly being used.

87

Pseudo Concave Cylindrical Polyhedral shell, new concept in offshore pipelines

Hossein Khalilpasha

Propagation buckling can cause catastrophic failure in offshore pipelines. To improve the buckling capacity of pipelines, a new concept, Pseudo Concave Cylindrical Polyhedral shell is proposed at this paper. The idea comes from the post-buckling configuration of an axially loaded cylindrical shell which offers some useful structural characteristics and in particular high circumferential flexural rigidity, therefore, a faceted cylindrical pipe is proposed instead of a conventional cylindrical pipe of the same D/t ratio. Preliminary FE analysis of this faceted pipe shows that a substantial increase in buckling capacity can be achieved for the same D/t ratio.

PRIZES

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- The Professor Gordon Dunlop Prize for best presentation related to Materials Engineering 2011 (Sponsored by CAST)
- The Professor Don Nicklin Prize for the best presentation related to Mining Engineering 2011 (Sponsored by CRCMining)
- The Professor John H Lavery Prize for best presentation related to Civil Engineering 2011 (Sponsored by Civil Engineering)
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