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# CALIFORNIA RENEWABLE ENERGY AND STORAGE TECHNOLOGY CONFERENCE

California State University, Northridge
University Student Union (USU), Saturday, November 18, 2017

## Poster Session: 11-11:30 AM

**1- How Sustainable Are CSUN Buildings?**

Rais Ahmad

**2- Thermosiphon Simulation with Applications in Geothermal Heating**

Alan Chung and Shadi Mahjoob

**3- Modeling Stresses and Volumetric Deformation in Lithium-Ion Batteries Using Chemo-Elasticity**

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**5- Effects of Dead-End Pores on Solute Transport Processes**

Sami Maalouf

# How Sustainable Are CSUN Buildings?

**Rais Ahmad**
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Green Design is a movement in the architectural and engineering disciplines to design and construct buildings by incorporating the local environment and taking advantage of natural resources in order to minimize the impact on local, regional, and global environment. Over the years, engineers and architects are implementing sustainable design concept by constructing buildings that enhance occupancy comfort while actively considering reduction of energy consumption, water usage, carbon emission and efficient usage of surrounding environment. Building systems consume large amount of energy and most of the buildings in the CSUN campus were not designed as energy efficient. California State University, Northridge (CSUN) is pursuing for sustainable infrastructures and is considered a leader in energy conservation among university's across the United States. Out of 23 large buildings in CSUN campus only two of the recently constructed buildings at CSUN (VPAC Building & Chaparral Hall) were designed to be energy efficient with LEED (Leadership and Energy in Environmental Design) “Gold” certification. But, it is imperative to assess how these buildings are performing regarding green revolution. Significant number of these energy inefficient buildings can be renovated or upgraded to provide higher level of efficiency. The objective of this proposed research project is to study how these “Green Buildings” are performing and evaluate how much sustainability they can offer in current condition and finally develop an optimized renovation model to increase the level of efficiency. In this research two separate buildings: the Oviatt Library and the Valley Performing Arts Center (VPAC) were taken as case studies.

# Thermosiphon Simulation with Applications in Geothermal Heating

**Alan Chung and Shadi Mahjoob**

Mechanical Engineering Department, California State University, Northridge

Geothermal technology is the application of using the temperature of the Earth to provide heating and cooling. One of the significant aspects that makes geothermal technology desirable is due to being a renewable resource and so providing an alternative to fuel-based heating and cooling. One of the devices that can be used in geothermal cooling specifically is the thermosiphon. A thermosiphon is a subset of a heat pipe where the latent heat of vaporization is used to transport heat from one location to another. The process of heat transfer in thermosiphns is passive and mainly relies on the difference in temperature from one end of the thermosiphon to the other. In this study, a thermosiphon is modeled numerically using ANSYS FLUENT 18.1. The working fluid is water under constant heat flux through the heat pipe. To account for the mass and energy transfer in the thermosiphon, a user-defined UDF was applied to FLUENT. The simulation showed presence of nucleation occurring at 0.3 s of flow time, column nucleation at 7.5 s, boiling at 14.2 s and reached a semi-steady state at 18.1 s.

# Modeling Stresses and Volumetric Deformation in Lithium-Ion Batteries Using Chemo-Elasticity

**Nicholas P. Fabry & Peter L. Bishay**
Mechanical Engineering Department, California State University Northridge

The demand for lithium-ion batteries has become increasingly important due to their high consumption in the portable electronics industry. While the batteries exhibit outstanding energy density ratios, they pose many safety concerns. In the past few years, several safety incidents have been observed because of lithium-ion battery failure. In July 2016, the Hoverboard was recalled due to exploding battery packs. The incidents left property damage, personal injuries and even killed a toddler. Lithium-ion batteries exhibit swelling due to the intercalation of lithium into the batteries electrodes. This phenomenon can be described by the coupling theory known as chemo-elasticity, where the mechanical field is coupled with the chemical concentration of a solute in a host material. The governing equations of this theory have been used to establish finite element models used to predict swelling and stresses of the host material. The 2D and 3D models utilize the weak form module in COMSOL and take advantage of the built-in meshing tools to analyze any chemo-elastic solid. Using these models, the analysis of a single thin film lithium-cobalt-oxide cathode is performed to predict the swelling behavior and study stresses under different constraint scenarios.

# Porous Metal-Organic Frameworks for Hydrogen Storage

**Phillip Farias**
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As the most porous family of materials, new metal-organic frameworks (MOFs) structures are being synthesized and studied for various applications. Hydrogen storage has been one of the major applications of MOFs that was extensively explored. Current methods of hydrogen storage include storing hydrogen gas at high pressures or cryogenic temperatures. In this work, we report five new porous MOFs based on a tetratopic ligand, aiming to achieve better ways to store hydrogen gas. By varying the metal salts and solvent in the solvothermal reaction, these MOFs exhibit different structural features. All of them showed impressive hydrogen storage capacities, especially the ionic Co-MOF, which reaches 2.64 wt% uptake at 77 K and 1 bar. Based on the hydrogen uptake data, a list of structural properties including catenation, metal nodes, charge, topology and pore size are reported and evaluated for hydrogen storage application. These structure-property relationship studies are effective in guiding the rational design of better MOFs for hydrogen storage. In turn, improved uptake capacity of MOFs for hydrogen storage can possibly allow the storage of hydrogen gas (H2) at low pressures and ambient temperatures, making MOFs an effective way to safely store hydrogen for use in energy storage applications such as fuel cells. The use of H2 gas with oxygen as a fuel mixture yields water vapor and air as waste products. Making the storage of hydrogen safer and easier would pave the way to a cleaner and renewable replacement for fossil fuels in the transportation industry.

# Effects of Dead-End Pores on Solute Transport Processes

**Sami Maalouf**
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Groundwater flows through voids and passages that are interconnected within porous media. Some of the pores are referred to as a dead-end pore space within the porous matrix. The presence of dead-end pores creates a "dead zone" where the advective and diffusive characteristics are affected. The exchange processes between the waters in the tortuous movement path of porous media and these dead zones become influenced as well. A method is developed and presented to solve for the influences of dead-end pores in the mass transport problem. The "dead zone" is treated as a finite volume or a zone between two or more obstructions where the constituent / contaminant is transported and/or removed from the dead-end pore. This is represented as a random walk problem based in part on statistical transport methods. The constituent / contaminant is simulated by starting a "particle" cloud that moves with the flow of movement path. This cloud is then superimposed by a random movement in the transverse direction, representing the diffusion.