WAY LEE CHENG, Ph.D.

ENROLLED ENGINEERING INTERN IN ONTARIO (EIT 100219099)

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RESEARCH INTERESTS

- Numerical Methods
- Heat and Mass Transfer
- Multi-phase Flow
- Non-Newtonian Fluid
- Engine Performance & Emissions
- Combustion Chemistry

MECHANICAL ENGINEERING • TRANSPORT PHENOMENA • NUMERICAL METHODS

- Exemplary academic and accomplished professional offering an advanced educational background in Mechanical Engineering Thermofluids, Combustion and Numerical Methods.
- Hands-on experience in multi-phase flow, heat and mass transfer, combustion, non-Newtonian fluid, statistics and quantitative analysis, numerical methodologies, and programming in differential equations.
- Deliver compelling research, analysis, documentation and presentations that clearly define research findings, engineering requirements, and technical advantages. Motivating teacher and educator.
- Outstanding communication, organization and analytical abilities, written and verbal.
- Manage multiple projects from concept through completion, working well both independently and as a productive member of the team.

EDUCATION

UNIVERSITY OF ILLINOIS - URBANA CHAMPAIGN, URBANA, IL 2010
- DOCTOR OF PHILOSOPHY, MECHANICAL ENGINEERING

NORTHWESTERN UNIVERSITY, EVANSTON, IL 2002
- MASTER OF ARTS, ECONOMICS

UNIVERSITY OF ILLINOIS - URBANA CHAMPAIGN, URBANA, IL 2001
- MASTER OF SCIENCE, MECHANICAL ENGINEERING

UNIVERSITY OF WISCONSIN - MADISON, MADISON, WI 1999
- BACHELOR OF SCIENCE (GRADUATED WITH DISTINCTION), MECHANICAL ENGINEERING

WORK EXPERIENCES

TEXAS A&M UNIVERSITY AT QATAR, DOHA, QATAR
POST-DOCTORAL RESEARCH ASSOCIATE, DEPARTMENT OF MECHANICAL ENGINEERING 2012 – CURRENT
PROJECT: HYDRODYNAMICS OF COLLOIDS WITH NANO-SIZED PARTICLES

- Developed a simulation scheme to simulate the fluid field induced by random motions of suspended nanoparticles in a base fluid.
- Characterized the transient velocity of flow field of a sphere moving in a quiescent fluid under the creeping flow regime, using Fluent.
- Designed a scaling rule to approximate the full transient hydrodynamic response of a multi-phase system.
- Studied the effects of random motions of the suspended particles on the thermal behaviors of nanofluids reported in the literature using a numerical/computational approach.
- Co-developed highly efficient computation scheme by utilizing GPU computational functionality or parallel coding techniques.

- **SELECTED ACHIEVEMENTS**
  - Developed a simulation scheme, computationally affordable, for simulating the fluid dynamics of nanofluids.
  - The fluid velocity at a randomly selected location in the induced, local convective flow field is not normally distributed, unlike particle velocity.
  - Showed that the random motions of particles would induce a localized velocity flow field in the fluid phase with statistical properties differ from a random White noise.
  - Verified that effects of Brownian motion on the induced fluid flow field are important only for particles with intermediate sizes.

PROJECT: MICROBIAL FUEL CELL / MICROBIAL ELECTROLYSIS CELL

- Analyzed mass diffusion behavior in micro-channel mixing of fuel cell, using a numerical approach.
- Optimized the channel configuration that minimized the mixing between the two parallel fluid flows.
- Examined the effects of diffusivity and viscosity of the fluid on the variation of the mixing zone.
- Constructed a dynamic model with moving mesh in Fluent to resemble the bacteria growth on the anode.
- Developed a database of mass diffusion characteristics for micro-channel mixing for optimizing the anode/cathode configurations in fuel cells.
- Analyzed the fluid dynamics inside the anode chamber to examine the reason for slow fluid replacement inside the chamber.
- Determined the important factors responsible for replacement rate of fluid in the chamber.
- Optimized the geometric design of the microbial electrolysis cell based on simulation results.

- **SELECTED ACHIEVEMENTS**
  - Successfully applied the simulation software in conducting micro-channel mixing flow.
  - Identified the channel configuration that minimizes mixing of the two fluid streams flowing through the micro-channel in the fuel cell.
  - Identified the regions that are appropriate for installing the cathode and anode parts for the fuel cell.
  - Identified the three important factors that affect fluid replacement in the anode chamber in a microbial electrolysis cell.
  - Identified regions of fluid recirculation zone and proposed a solution to eliminate these zones.
  - Suggested an optimized anode chamber configuration that improves fluid replacement rate.

TAIWAN SEMICONDUCTOR MANUFACTURING COMPANY LIMITED, HSINCHU, TAIWAN
PRINCIPAL ENGINEER 2011 - 2012

- Examined heat and fluid flows within electronic packages with the use of ANSYS thermal packages to determine performance of current thermal solutions and seek possible improvements.
- Examined under-fill flows within electronic packages with the use of Fluent software to predict and visualize flow evolution. Determined any possibilities for void formation, and recommended ways to prevent or eliminate voids.
- Designed effective cooling systems for use in electronic packages.
- Developed effective epoxy filling processes with low risk of void formation.
- Co-designed the thermal test vehicle for thermal reliability and power cycling tests.
- Built three-dimensional models using HyperMesh for FEM and/or CFD analysis.
- Created CAD models for parts using SolidWorks.
- Prepared technical documentation for all design, model and process flows for the group.

- **SELECTED ACHIEVEMENTS**
  - Made recommendations on a solution and provided guidelines regarding air trapping in the under-fill process, effectively minimizing void formation in the underfill layout and improving thermal and mechanical performance of the packages. These guidelines also reduced the amount of trial and error in future experimentations.

UNIVERSITY OF ILLINOIS AT URBANA CHAMPAIGN, URBANA, IL
RESEARCH ASSISTANT, SUMMER INTERNSHIP - FUNDED BY CATERPILLAR SUMMER 2006

- Analyzed effects on engine performance from a thermoelectric device which was inserted into the engine, aimed at recycling otherwise wasted power to other components.
- Simulated engine operation with different configuration of the thermoelectric device, and identified configuration that best maintained overall engine efficiency following insertion. Identified further device improvements.

- **SELECTED ACHIEVEMENTS**
  - Recommended and presented findings for insertion of the thermoelectric device to the Production Department, illustrating a reduction of extra input power required for other components of the vehicle and selecting a configuration least sensitive to engine performance.

RESEARCH ASSISTANT, DEPARTMENT OF MECHANICAL SCIENCE AND ENGINEERING 2004 - 2010

- Analyzed multi-component effects on evaporation of biodiesel and blends, and on engine performance and emissions, and

identified mechanisms and causes for emission levels observed.
- Examined strategies to simultaneously reduce NO_x and soot for diesel-biodiesel operations in diesel engines.
- Developed model using continuous thermodynamics to compute evaporation rate of a complicated liquid mixture.
- Implemented a numerical scheme to the model and integrated it into an engine. Simulated engine operation with biodiesel using a three-dimensional numerical model. Simulation code was written in Fortran.
- Co-studied micro-explosion phenomenon, significantly improving the atomization and evaporation of fuel spray in biofuel and petroleum-based fuel blends.

- **SELECTED ACHIEVEMENTS**
  - Proved that multiple injections can be used to simultaneously reduce NO_x and soot in diesel biodiesel mixture; with the initial fuel injection creating an ambient favorable for fuel evaporation and air-fuel mixing, allowing a reduction of combustion temperature.
  - Developed thermodynamics model showing excellent prediction of droplet surface regression, allowing easy tracing of mixture composition during evaporation process. Model can be implemented into the engine code, significantly improving computational efficiency of the fuel spray evaporation process.

RESEARCH ASSISTANT, DEPARTMENT OF MECHANICAL SCIENCE AND ENGINEERING 1999 - 2001

- Developed a mathematical model using a wide band cumulative distribution function to improve computational efficiency of thermal radiation absorption through a gaseous mixture.
- Implemented a computer code, in Fortran, for the developed model.

- **SELECTED ACHIEVEMENTS**
  - New model significantly improved computational efficiency of thermal radiation through a participating medium.

TEACHING EXPERIENCE

UNIVERSITY OF ILLINOIS - URBANA CHAMPAIGN, URBANA, IL
TEACHING ASSISTANT, DEPARTMENT OF MECHANICAL SCIENCE AND ENGINEERING 2004 - 2010

- Full responsibility instructor for the undergraduate Introductory Thermodynamics course in Summer 2010.
- Taught engineering courses, and directed lab sections of introductory level thermodynamics, fluid mechanics and heat transfer. Developed dynamic curriculum and executed lesson plans aimed at educating and empowering students from a wide range of socioeconomic backgrounds and cultures.
- Lead help sections for students in upper undergraduate and lower graduate elective courses in Internal Combustion Engines grading homework assignments and assisted in exam grading. Delivered occasional substitute lectures.
- Assisted and organized help sections in the graduate level Design of IC Engine course.

- **SELECTED ACHIEVEMENTS**
  - Elected by students to the *Incomplete List of Teaching Excellence* for superior teaching, performance and dedication.

COMPUTER SKILLS

- Extensive experience in Fortran programming, designing and implementation of numerical solver and simulations of the diffusion/conduction process.
- Computer proficient in Fortran, C/C++, Matlab, AutoCAD, AMPL, Ansys, EES, FieldView, Fluent, HyperMesh, Kaleidegraph, KIVA, Maple, Mathematica, Microsoft Office, ProEngineer, SolidWorks, STATA, Mac, Windows, LINUX/UNIX.

PROFESSIONAL ACTIVITIES AND SERVICES

MENTORING EXPERIENCE
TEXAS A&M UNIVERSITY AT QATAR

- Assisted the undergraduate student worker to the Micro Scale Thermo-Fluid Lab in setting up the geometric models for computational simulations of a micro-fuel cell.
- Provided the necessary training, advice and technical assistance in mathematical modeling, data analysis and numerical methods in the Fluent simulations.

UNIVERSITY OF ILLINOIS - URBANA CHAMPAIGN

- Assisted new members to the IC Engine Laboratory in getting themselves oriented to their computational research work.
- Provided the necessary training for conducting KIVA-3V engines simulations to all new members.
- Provided advice and technical assistance in mathematical and analytical analysis/derivations, numerical methods and programming pertaining to their researches.
- New members to the IC Engine Lab mentored:
  - Master of Science candidate, 2005 to 06
  - Doctorate candidate, 2008 to 09
  - Visiting research assistant, 2008 to 09

TECHNICAL REVIEWER FOR

- Atomization and Spray (on behalf of Professor C. F. Lee, multiple occasions)
- Journal of Fluid Mechanics (on behalf of Professor R. Sadr)
- ASME International Mechanical Engineering Congress and Exposition 2015

PUBLISHED WORKS

JOURNAL PAPERS

1. Saleem, A., Cheng, W. L. and Sadr, R., "Recent Trends in Temperature Extremes in the Coastal Region of Qatar," Theoretical and Applied Climatology, 1-13, 2015.
2. Cheng, W. L. and Sadr, R., "Induced Flow Field of Randomly Moving Nanoparticles: A Statistical Perspective," Microfluidics and Nanofluidics, 18(5-6): 1317-1328, 2015.
3. Cheng, W. L., Sheharyar, A. and Sadr, R., "Application of GPU Processing for Brownian Particles Simulation," Computer Physics Communications, 186: 39-47, 2015.
4. Shen, C., Cheng, W. L., Lee, C. F., and Lee, T. H., "Using Continuous Thermodynamics Method to Investigate the Multi-components Fuel Droplet Evaporation," Journal of Engineering Thermophysics, *Accepted for Publication*, 2013.
5. Cheng, W. L., Shen, C. and Lee, C. F., "A Multi-Distribution Functions Droplet Evaporation Model using Continuous Thermodynamics," SAE International Journal of Fuels and Lubricants, 5:2, 567-575, 2012.
6. Shen, C., Cheng, W. L. and Lee, C. F., "Micro-Explosion Modeling of Biofuel-Diesel Blended Droplets," SAE International Journal of Engines, 4(1): 1445-1454, 2011.
7. Ruan, D. F., Cheng W. L., and Lee, C. F., "Comparison of Performance and Combustion Characteristics of Diesel Fuel and Vegetable Oils in DI Diesel Engine," SAE International Journal of Fuels and Lubricants, 1(1): 1049-1055, 2009.
8. Lee, C. F., Cheng, W. L. and Wang, D., "Finite Diffusion Wall Film Evaporation Model for Engine Simulations using Continuous Thermodynamics," Proceedings of the Combustion Institute, 32(2): 2801-2808, 2009.
9. He, J., Cheng, W. L. and Buckius, R. O., "Wide Band Cumulative Absorption Coefficient Distribution Model for Overlapping Absorption in H_2O and CO_2 Mixtures," International Journal of Heat and Mass Transfer, 51: 1467-74, 2008.

TECHNICAL PAPERS

1. Shen, C., Cheng, W. L., and Lee, C. F., "The Effects of Spray Angles on Spray Combustion of Diesel and Biodiesel in Diesel Engines," ASME Technical Paper ICEF2014-5647, 2014.
2. Cheng, W. L., and Sadr, R., "A Numerical Approach in Predicting Flow Field Induced by Randomly Moving Nano Particles," ASME Technical Paper MNHMT2013-221132013, 2013.
3. Shen. C., Cheng, W. L. and Lee, C. F., "Micro-Explosion Study of Butanol Biodiesel Diesel Blend Bio-Fuel Droplets," SAE Paper 2011-01-1189, 2011.
4. Hou, D., Huang, Y., Huo, M., Cheng, W. L., Feng, X., Shen, C. and Lee, C. F., "Spray and Atomization Characterization of a Micro-Variable Circular-Orifice (MVCO) Fuel Injector," SAE Technical Paper 2011-01-0679, 2011.
5. Liu, Y., Cheng, W. L., Huo, M., Lee, C. F. and Li, J., "A Study of Effects of Volatility on Butanol-Biodiesel-Diesel Spray and Combustion," SAE Technical Paper 2011-01-1197, 2011.
6. Hou, D., Zhang, H., Kalish, Y., Lee, C. F. and Cheng, W. L., "Adaptive PCCI Using Micro-Variable Circular-Orifice (MVCO) Fuel Injector - Key Enabling Technologies for High Efficiency Clean Diesel Engines," SAE Technical Paper 2009-01-1528, 2009.
7. Cheng, W. L., Lee, C. F. and Hou, D., "Comparison of the Operation of a Small-Bore High-Speed Direction-Injection Engine using a Micro-Variable Circular-Orifice (MVCO) Injector and Conventional Fuel Injectors," SAE Technical Paper 2009-01-0718, 2009.
8. Stringer, V., Lee, C. F., Cheng, W. L. and Hansen, A. C., "Operation of an HSDI Engine using Multiple Injection Schemes with Soybean Biodiesel, Diesel and their Blends," SAE Technical Paper 2009-01-0719, 2009.
9. Ruan, D. F., Cheng, W. L. and Lee, C. F., "Comparison of Performance and Combustion Characteristics of Diesel Fuel and Vegetable Oils in DI Diesel Engine," SAE Technical Paper 2008-01-1639 in 2008 SAE International Powertrains, Fuels and Lubricants Congress, Shanghai, China, June 2008.
10. Cheng, W. L., Lee, C. F. and Ruan, D. F., "Comparisons of Combustion Characteristics of Biodiesels in a High Speed Direct Injection Diesel Engine," SAE Technical Paper 2008-01-1638 in 2008 SAE International Powertrains, Fuels and Lubricants Congress, Shanghai, China, June 2008.
11. Stringer, V. L., Cheng, W. L., Lee, C. F. and Hansen, A. C., "Combustion and Emissions of Biodiesel and Diesel Fuels in Direct Injection Compression Ignition Engines using Multiple Injection Strategies," SAE Technical Paper 2008-01-1388, 2008.

CONFERENCE PAPERS

1. Shen. C., Cheng, W. L. and Lee, C. F., "Droplet Evaporation Modeling Using Continuous Thermodynamics Method," 2012 Conference of Chinese Society of Engineering Thermophysics, 126011, Xian, China, Oct. 2012.
2. Cheng, W. L., Shen. C. and Lee, C. F., "Application of Continuous Thermodynamics Method to Fuel Droplet Evaporation," ASME Paper ICEF2012-92177 in Proceedings of the ASME 2012 Internal Combustion Engine Division Fall Technical Conference, Vancouver, BC, Canada, Sept. 2012.
3. Shen. C., Cheng, W. L. and Lee, C. F., "Finite Diffusion Multi-components Fuel Droplet Vaporization Modeling using Continuous Thermodynamics for Fuels with Distinct Composition Distributions," Proceedings of ICLASS 2012, 12th Triennial International Annual Conference on Liquid Atomization and Spray Systems, Heidelberg, Germany, Sept. 2012.
4. Shen. C., Cheng, W. L. and Lee, C. F., "Fuel Droplet Evaporation Modeling using Continuous Thermodynamics Method with Multi-Distribution Functions," IMEM Paper in 2012 International Multidimensional Engine Modeling User's Group Meeting at the SAE Congress, Detroit, MI, April 2012.
5. Shen. C., Cheng, W. L. and Lee, C. F., "Vaporization Modeling of a Multi-components Fuel Droplet Using Continuous Thermodynamics," Proceedings of ILASS-Asia 2011, 15th Annual Conference on Liquid Atomization and Spray Systems - Asia, Pingtung, Taiwan, Oct. 2011.
6. Cheng, W. L. and Lee, C. F., "A Droplet Preferential Evaporation Model using Continuous Thermodynamics Formulation," Proceeding of Central States Section of the Combustion Institute 2010 Technical Meeting, Champaign, Illinois, March 2010.
7. Shen, C., Cheng, W. L., Wang, K. T. and Lee, C. F., "Breakup Determination and Distribution of Secondary Droplets for Biofuel-Diesel Blends under Micro-Explosion," Proceeding of Central States Section of the Combustion Institute 2010 Technical Meeting, Champaign, Illinois, March 2010.
8. Liu, Y., Cheng, W. L., Lee, C. F. and Li, J., "A Study of the Effects of Volatility on Butanol-Biodiesel-Diesel Spray and Combustion," Proceeding of Central States Section of the Combustion Institute 2010 Technical Meeting, Champaign, Illinois, March 2010.
9. Cheng, W. L. and Lee, C. F., "The Effects of MVCO Injections and Conventional Fuel Injections in a High Speed Direction Injection Engine," Proceeding of ICLASS 2009, 11th Triennial International Annual Conference on Liquid Atomization and Spray Systems, Vail, Colorado USA, July 2009.
10. Cheng, W. L., Leick, M., and Lee, C. F., "The Effects of Spray Angles on Spray Combustion of Diesel and Biodiesel in Diesel Engines," Proceeding of the 13th Annual Conference on Liquid Atomization and Spray Systems – Asia, Wuxi, P. R. China, October 2009.
11. Wang, D., Cheng, W. L. and Lee, C. F., "Finite Diffusion Wall Film Evaporation Model for Engine Simulations Using Continuous Thermodynamics," Proceedings of the 32nd International Symposium on Combustion, Montréal, Québec, Canada, August, 2008.
12. Cheng, W. L., Stringer, V. L., McCrady, J. P., Hansen, A. C. and Lee, C. F., "Comparisons between a High Speed Direct Injection Engine Operating with Biodiesel and Petroleum Based Diesel," Proceedings of the 20th Annual Conference on Liquid Atomization and Spray Systems, Chicago, IL, May 2007.
13. Cheng, W. L., Wang, R. C., Zhao, J. X., and Lee, C. F., "A Comparison of Numerical Results for an Optically Accessible HSDI Diesel Engine with Experimental Data," Proceedings of the 16th International Engine Combustion Multidimensional Modeling Conference, Detroit, MI, March 2006.

PATENT APPLICATION

1. Hsieh, C. C., Cheng, W. L., Hou, S. Y. and Jeng, S. P., "Thermal Structure for Integrated Circuit Package," U.S. Patent Application 13/546,218, filed July 11, 2012.

List of references is available upon request.