

## Sang-Rin Lee

Home: Oakdale Duplex B.  
Oakdale campus  
Iowa city, IA 52242  
Nationality: South Korea

Office: Chemical. Eng.  
417 IATL  
University of IOWA  
Iowa city, IA 52242  
Tel.:319-335-3336

### EDUCATION

1999- 2005      PhD. Environmental Engineering & Sciences, University of Florida  
1995              M.S. Environmental engineering, Inha University, Korea  
*Thesis Title:* Application of the STEM II to air pollutant  
                         transport/chemistry/deposition in the Korea and eastern china area  
1993              B.S. Environmental engineering, Inha University, Korea

### DISSERTATION

Title: Mechanistic study of sorbent injection for vanadium emission control in combustion systems

**Abstract:** Heavy metal emissions from combustion sources such as utility boilers and incinerators are of great concern because of their adverse effects on human health and the environment. Vanadium is one of these metals and concentrated in submicron regime (0.01 to 1  $\mu\text{m}$ ). These size particles showed the lowest collection efficiency for traditional air pollution control devices. Sorbent technique is one of promising measures to remove submicron particles. Mineral sorbent (supermicron) injected and vanadium vapor adsorbed on the surface of sorbent. This study is about investigating mechanism of sorbent injection technique to control vanadium emission in combustion system. Mechanism of sorbent technique was found experimentally and theoretically. This finding will be applied to control other metal compound because its principal is same. Thus, this work helps people in our society enjoy fresh air and clean environment.

*Learned from this study;* I did thermodynamic equilibrium analysis using STAN software. I developed an aerosol dynamic model (Modal Aerosol Dynamic Model) using Fortran for theoretical study. I used several particle instruments such as Low pressure impactor, SMPS, ultrasonic nebulizer, collision nebulizer, and Wright dust feeder. I learned how to use analytical instruments such as XRD, ICP, Raman spectroscopy and SEM/EDX.

### PROFESSIONAL AFFILIATIONS

1993 – 1994      Member, Korea Society of Environmental Engineer  
1993 – 1994      Member, Korea Society for Atmospheric Environment  
2000 – 2000      Member, Florida Air & Waste Management  
2002 – 2004      Student Assistant, AAAR conference  
2005 – current    Member, American Associate for Aerosol Research  
2007 - current    Member, Air & Waste Management Association

## HONOR

- 2001 Sally & Glick scholarship award  
2000 Florida AWMA scholarship award

## RESEARCH EXPERIENCE

**2006- current                      Research Scientist at University of Iowa**

**Title: Development and application of a Personal Exposure Screening Model for size-resolved Urban Aerosol**

*Objectives:* The objective of this project is to make a significant advancement in the prediction and understanding of human exposure to fine and ultrafine particulate matter. It is aimed to build, evaluate, and share with health effects and aerosol communities a model that produces detailed predictions about the aerosols in an individual's breathing zone, given key information on sources, meteorology, and the location of the exposed individual.

**2005- 2006                      Post Doctorial Researcher at Clarkson University**

**Title: Design and Development of Wide Range Impactor Particle Sampler (WRIPS)**

*Synopsis:* I am working on the design and development of a new instrument which is called Wide Range Impactor Particle Sampler. This sampler is for large particles (bigger than 10  $\mu\text{m}$ ) in various wind speeds. Our target is to sample particles up to 60  $\mu\text{m}$  with at least 40% inlet efficiency at wind speeds up to 7m/s. To this point, I have done 3D CFD modeling using Fluent (Fluent Inc. NH) to investigate flow fields developed inside and around the instrument and used Fluent's discrete phase model to predict particle trajectories for a theoretical inlet efficiency calculation. Using the CFD results, I designed the Large Particle Inlet (LPI). Wind tunnels experiments show that the LPI can sample particles up to 100  $\mu\text{m}$  with 30% inlet efficiency at a mild wind speed (3.5m/s). To evaluate the LPI, it was necessary to develop an effective method for generating large particles in a wind tunnel, since there has been little prior works on this area. To characterize the large particle generation method, I developed a new passive impactor with sharp cut-off size (7 $\mu\text{m}$  at 7m/s). Experiments showed a good agreement with CFD modeling results.

*Learned from this project:* Fluent, Gambit (Meshing software). Aerosol generation instruments such as Vibrating Orifice Aerosol Generator, Spinning Disk Aerosol generator, and Dust Feeder. Aerosol measurements instruments such as Aerosol Particle Sizer (TSI), WPS(MSP) and Passive Impactor.

**1999- 2005    University of Florida, Env. Eng. Sci., Research assistant**

**2002- 2005                      Sorbent Injection Technique**

*Synopsis: Same as dissertation*

**1999- 2001    Alachua County air monitoring project**

*Synopsis:* My first project at UF was Alachua County air monitoring. I managed two air monitoring sites. One was on the UF campus and the other was in a suburban area. SO<sub>2</sub>, NO<sub>x</sub>,

and Ozone were monitored. I managed instruments (zero/span check, multi-point calibration) to meet EPA criteria for these gas phase pollutants. I developed an auto data transfer system to update measurement data to a website daily.

*Learned from this project:* PCanywhere (Symantec), SO<sub>2</sub>, NO<sub>x</sub> and Ozone analyzer. EPA criteria for air monitoring site.

### **1993-1995 Inha University, Environ. Research center, research assistant**

I participated in many air quality monitoring projects during this time. I also worked on Acid rain modeling.

## **WORK EXPERIENCE**

### **1999 – 1996 Korea Power Engineering Company, Process Engineer**

*Synopsis:* I worked for the Korea Power Engineering Company for three years as a process engineer. I worked on the design and construction of the first Korean type Flue Gas Desulfurization system for the Young-Dong Power Plant (200MW and 150MW). This novel FGD system was developed by the research center of the Korea Power Company. They built and evaluated a 10MW FGD system, and we scaled up and constructed this system at the Young-Dong Power plant. This was a part of G7 project funded by Korean government. Because this was the new FGD system, our team of process engineers played the most important role. We provided all of the design parameters to the other teams. This project had a lot of responsibility, but it was still fun. I also participated in the preliminary operation of the FGD system at the Young-Dong Power Plant for two months before the system was fully operating.

### **1995.2 – 1995.11 LG-PERC, Research engineer.**

I worked on safety and working environment of electronics manufacturing plants.

## **COMPUTER SKILLS**

Fluent 6.2.16 : 2D and 3D simulation

Gambit: Grid generation for 2D and 3D

Programming language: Fortran and visual basic

Word and graphic program: MS office, Sigma plot

Math software: Mathcad and Matlab.

Data acquisition program: Labview: Since our DMA is the old version (3070 TSI), I bought a DAQ card and wrote Labview program by myself for automated size measurement (SMPS).

Unix(Workstation): Sun and Hp I used these workstation for my MS thesis study. I'm using Dell workstation for Fluent simulation now.

## **INSTRUMENTS**

Air monitoring instruments: SO<sub>2</sub>, NO<sub>x</sub>, Ozone analyzer.

Aerosol instruments: Low pressure impactor, Washington impactor, High volume air sampler, SMPS, WPS, and EAA

Aerosol generation: Ultrasonic nebulizer, collision nebulizer, Vibrating Orifice Aerosol Generator, Spinning Top Disk Aerosol Generator (BGI).

Element concentration: ICP, GC-Mass

Morphology and speciation: SEM/EDX, BET, XRD, Raman, GC/MS and TGA

Flow measurement: Pito-tube, S tube, Rota meter, Wet test meter, Mass flow meter and Gilibrator

Large particle generation: Dust feeder, Mechanical sieve and passive impactor

Microscope: Particle size measurement and data analysis program (Meta-morph)

Aerosol Wind Tunnel

Micro balance: Down to  $10^{-5}$  g.

## **PATENT**

**Lee, S.R.**, Dhaniyala, S. and Holsen, T.M., “Design and development of novel large particle inlet for PM larger than  $10\mu\text{m}$  (PM<sub>10</sub>), Provisional patent, Appl no 60/960,168, Confirm no. 6509

## **PUBLICATION**

**Lee, S.R.**, Dhaniyala S, and Holsen, T.M., “Design and Development of Novel Large Particle Inlet for PM larger than  $10\mu\text{m}$  (PM<sub>>10</sub>)”, *Aerosol Sci and Tech.*, will be published in 41(1). 2008

**Lee, S. R.**, Andino, J. M., and Wu, C. Y., “Mechanism of vanadium-sorbent surface interaction at high temperature, *Aerosol Sci and Tech*”, Doi:10.1080/02786820701697796,41(12) 2007

Li, Y., **Lee, S.R.** and Wu, C. Y., 2006, “UV-Absorption-Based Measurements of Ozone and Mercury: An Investigation on Their Mutual Interferences”, *Aerosol and Air Quality Research*, 4(6), p 418 - 429

**Lee, S.R.**, and Wu, C. Y., 2005, Size Distribution Evolution of Fine Aerosols due to Inter-coagulation with Coarse Aerosols, *Aerosol Sci. and Tech.*, 39 (4): 358-370

**Lee, S.R.**, and Wu, C. Y., 2002, Study of vanadium emission control in combustion systems by thermodynamic equilibrium analyses, *Advances in Env. Research*, v 7, p 1-10

**Lee, S. R.**, Cho, S. Y., and Shim, S. G., 1995, Application of the STEM II to air pollutant transport/chemistry/deposition in the Korea and eastern china area: II. Transport of SO<sub>2</sub> and sulfate between the Korea and eastern China area, *J. of KAPRA*, v 11, p 163-170

**Lee, S. R.**, Cho, S. Y., and Shim, S. G., 1995, Application of the STEM II to air pollutant transport/chemistry/deposition in the Korea and eastern china area: I. Data preparation and model verification, *J. of KAPRA*, v 10, p 260-280

## **IN PREPARATION**

**Lee, S. R.**, Dhaniyala, S., and Holsen, M. T., 2007, “Study of Large Particle Seeding and Evaluation of a Novel Large Particle Inlet in Large Scale Wind tunnel”.

**Lee, S. R.**, Dhaniyala, S., and Holsen, M. T., 2007, “Design and Development of a Passive Large Particle Impactor for wind tunnel”

**Lee, S. R.**, Dhaniyala, S., and Holsen, M. T., 2007, “Design and Development of 2 stage Virtual Impactor as Large Particle Concentrator”.

## **CONFERENCE PRESENTATIONS / PROCEEDINGS**

**Lee, S. R.**, Dhaniyala, S., and Holsen, M. T., “Design and Development of a Passive Large Particle Impactor”, 26th Annual Conference of American Association for Aerosol Research, Abstract No. 2P1, Reno, NV, Sept 24-28, 2007, **Poster**

**Lee, S. R.**, Dhaniyala, S., and Holsen, M. T., “Wind Tunnel Evaluation of a Novel Large Particle Inlet (LPI)”, 26<sup>th</sup> Annual Conference of American Association for Aerosol Research,

- Abstract No. 2P2, Reno, NV, Sept 24-28, 2007, **Poster**
- Lee, S. R.**, Dhaniyala, S., and Holsen, M. T., “Design and Development of Wide Range Impactor Particle Sampler: Part II: Large particle concentrator (Two-stage Virtual Impactor)”, 26<sup>th</sup> Annual Conference of American Association for Aerosol Research, Abstract No. 5C3, Reno, NV, Sept 24-28, 2007, **Platform**
- Benerjee, K., Lee, S. R.**, Dhaniyala, S., and Holsen, M. T., “A New Instrument for Large Particle (10 – 100 micron) Size-Segregated Analysis”, 26<sup>th</sup> Annual Conference of American Association for Aerosol Research, Abstract No. 2P6, Reno, NV, Sept 24-28, 2007, **Poster**
- Lee, S. R.**, Dhaniyala, S., and Holsen, M. T., “Design and Development of Wide Range Impactor Particle Sampler (WRIPS)”, 7<sup>th</sup> International Aerosol Conference, Abstract No. 2D4, St. Paul, MN, Sept 10-15, 2006. **Platform** presentation
- Lee, S. R.**, Dhaniyala, S., and Holsen, M. T., "Design and development of a large particle inlet", 7<sup>th</sup> International Aerosol Conference, Abstract No. 6H10, St. Paul, MN, Sept 10-15, 2006. **Poster.**
- Benerjee, K., Lee, S. R.**, Dhaniyala, S., and Holsen, M. T., "A new instrument size-segregated, near-real time volatility characterization of fine and coarse particle”, 7<sup>th</sup> International Aerosol Conference, Abstract No. 5G27, St. Paul, MN, Sept 10-15, 2006., **Poster.**
- Li, Ying, Lee, S. R.**, and Wu C. Y., “Interactive Interferences of mercury and ozone measurements, 99<sup>th</sup> Annual conference of Air & Waste Management, June 21-23,2006, New Orleans, LA, **Platform**
- Lee, S. R.**, Dhaniyala, S., and Holsen, M. T., “Design Wide-Range Impactor Particle Sampler (WRIPS) for chemical analysis”, 24<sup>th</sup> Annual Conference of American Association for Aerosol Research, Abstract No. 1PL27, Austin, TX, Oct. 17-21, 2005. **Poster**
- Lee, S. R.**, Dhaniyala, S., and Holsen, M. T., “Design of an inlet for ambient sampling of large (super-10µm) particles”, 24<sup>th</sup> Annual Conference of American Association for Aerosol Research, Abstract No. 1PL29, Austin, TX, Oct. 17-21, 2005., **Poster**
- Lee, S. R.**, and Wu, C. Y., “Mechanistic study of vanadium-sorbent surface interaction at high temperature”, 24<sup>th</sup> Annual Conference of American Association for Aerosol Research, Abstract No. 1PL53, Austin, TX, Oct. 17-21, 2005., **Poster**
- Lee, S. R.** and Wu, C. Y., “Study of fine aerosol size distribution change due to inter-coagulation with coarse aerosol”, 23rd Annual Conference of American Association for Aerosol Research, Abstract No. 9A3, Atlanta, GA, October 4-8, 2004., **Platform** presentation
- Lee, S. R.** and Wu, C. Y., “Mechanism of Sorbent Injection Technique to Control Vanadium Emission in Combustion System”, 22nd Annual Conference of American Association for Aerosol Research, Abstract No. 5D1, Anaheim, CA, October 20-24, 2003., **Platform** presentation.
- Lee, S. R.** and Wu, C. Y., "Study of Vanadium Emission Control in Combustion Systems by Sorbent Injection Technique", 21st Annual Conference of American Association for Aerosol Research, Abstract No. PE1-01, p179, Charlotte, NC, October 7-11, 2002., **Poster**
- Lee, S. R.** and *Wu, C. Y.*, "A Study of Vanadium Emission Control in Combustion Systems By Sorbent Injection Technique", 6th International Aerosol Conference, Abstract No. Th2G1, p. 799-800, Taipei, Taiwan, September 8-13, 2002.
- Lee, S. R.** and *Wu, C. Y.*, "Study of Vanadium Emission Control in Combustion Systems by Thermodynamic Equilibrium Analyses", 93rd Annual Meeting of the Air & Waste

Management Association, Salt lake City, UT, June 18-22, 2000, Paper No. 408.

**Lee, S. R.** and *Wu, C. Y.*, "Study of the Effects of Aerosol Dynamics on the Performance of a Cyclone", First Asian Particle Technology Symposium (APT 2000), Abstract No. S-VI-3 #0077, Bangkok, Thailand, December 13-15, 2000, p.124.

**Lee, S. R.** and *Wu, C. Y.*, "Capture of Vanadium by Mineral Sorbent Materials in Combustion Systems: A Thermodynamic Equilibrium Analysis", 38th Annual Conference of Florida Section of Air & Waste Management Association, Clearwater, FL, September 10-12, 2000., **Platform** presentation

**Lee, S. R.**, and *Wu, C. Y.*, "Study of the Capture of Vanadium in Combustion Systems Using Thermodynamic Equilibrium Analyses", 220th ACS National Meeting, Preprints of Symposia, Volume 45, No.3, p. 568-572, Washington, D.C., August 20-24, 2000.