Mechanical Engineering Doctoral Defense

Optimization of Complex Thermal-Fluid Processes

School for Engineering of Matter, Transport and Energy

Joon Young Lee

Advisor: Dr. Tae-Woo Lee

abstract

First, in a large-scale structure, a 3-D CFD model was built to simulate flow and temperature distributions. The flow patterns and temperature distributions are characterized and validated through spot measurements. The detailed understanding of them then allows for optimization of the HVAC configuration because identification of the problematic flow patterns and temperature mis-distributions leads to some corrective measures. Second, an appropriate form of the viscous dissipation term in the integral form of the conservation equation was considered, and the effects of momentum terms on the computed drop size in pressure-atomized sprays were examined. The Sauter mean diameter (SMD) calculated in this manner agrees well with experimental data of the drop velocities and sizes. Using the suggested equation with the revised treatment of liquid momentum setup, injection parameters can be directly input to the system of equations. Thus, this approach is capable of incorporating the effects of injection parameters for further considerations of the drop and velocity distributions under a wide range of spray geometry and injection conditions. Lastly, estimation method of groundwater level using compressed sensing (CS) was investigated. To satisfy a general property of CS, a random measurement matrix was used. The groundwater network was constructed, and finally l-1 optimization was run. Through several validation tests, correct estimation of groundwater levels by the suggested method was demonstrated. Using this setup, decreasing trends in groundwater level in the southwestern US were examined. The suggested method is effective in that the total measurements of registered wells can be reduced down by approximately 42 %, sparse data can be visualized and a possible approach for groundwater management during extreme weather changes is shown.

April 29, 2015; 2:00 PM; ERC 593