An Integrated Simulation and Design Optimization Tool for a Micro-Scale Absorption Cycle Portable Cooling System

Ashutosh Ballal, Ping Ge, Brian J. Daniels, Kevin Drost
Oregon State University
Corvallis, OR

Portable cooling systems can be used by soldiers, fire fighters, and personnel working in bio/chemical hazardous environments. The cooling system targeted is a self-contained absorption cycle based on microscale thermal technology. Light weight is crucial for enhancing portability and maintaining the desired thermal efficiency of such a portable cooling system. The primary design challenges are 1) multiphysics considerations when integrating the thermo-dynamic and transport models for the heat pump and peripheral component devices and 2) trade-off among multifunctional design requirements of system weight and thermal efficiency, using the inputs of cooling load, heat rejection temperature, and heat transfer characteristics based on the microchannel geometry. At present no design tool is available to support such a system. Our goal is to develop a design optimization tool that will help the designers and manufacturers search for cooling system design alternatives that will yield low weight with desired thermal efficiency. The tool will perform the following functions: 1) simulate and model the cooling system, 2) perform trade off studies, and 3) generate robust design alternatives. For the design tool to perform, thermal models of the system are developed and validated against state-of-the-art prototypes. The system modeling methodology is implemented in Java to make the design tool flexible and easy to use. Initial tradeoff results based on a typical 150 W portable cooling system suggests that the tool is effective and is a significant step toward a complete integrated design support environment.