CFD Modeling for Data Center Design

Written by Staff Writer

TUESDAY, 19 JANUARY 2010

A critical consideration in the design of data centers is heat management. Hot spots and inadequate cooling can lead to equipment failure, but developing a simple model of a data center can be challenging. In addition to modeling the layout of the facility, including walls, floors, and ceilings, special attention must also be given to cooling equipment and the various shapes, sizes, and heat outputs of the computer equipment. Accurate analytical models for all but the simplest data center configurations are difficult, if not impossible, to develop. A potential solution, however, is computational fluid dynamics (CFD) modeling, which uses a numerical approach to computing the air-flow characteristics of a data center. CFD modeling has also been used for such applications as calculating the aerodynamic characteristics of aircraft.

The CFD approach involves dividing the data center (whether a currently existing facility or a potential facility under design) into a mesh of small volume elements. Instead of modeling every single point in space (an infinitely complex task unless an analytical model is available), a CFD model considers a finite number of volume elements, making it possible for a sufficiently powerful computer to calculate the air-flow characteristics in a reasonable amount of time. In addition, a CFD model must consider boundary conditions (for instance, what happens at walls and floors) and heat sources (including computer equipment).

Data center designers recommend CFD as a way to anticipate both the heat dynamics of a proposed data center design as well as the necessary cooling requirements. By developing a computational model before construction, the design can be optimized to achieve both maximum equipment capacity and minimum required cooling equipment. This type of investment in data center design optimization prior to construction can lead to lower cooling costs and reduced risk of equipment damage or failure owing to overheating. These benefits by themselves can, in the long term, balance the initial design and optimization costs incurred by a company. In addition to new construction, CFD modeling can serve to improve the operation of current data centers, potentially allowing companies to delay or even avoid entirely the need to construct a new data center. Thus, in addition to simply being a tool for designers to improve the process of data center optimization, CFD modeling can serve as something of an insurance policy that pays off by anticipating potential hot spots and other heat-related concerns.

The benefits of CFD modeling to companies considering construction of a new data center include the ability to examine different layouts, thereby providing options when selecting a design. Good CFD models should provide the company with reasonably accurate cooling requirements and equipment capacities, allowing it to select a design that meets both computational requirements as well as budget requirements. Problems associated with inadequate air flow or hot spots can be addressed in a computer rather than by trial and (potentially devastating) error after construction. By optimizing the design through even small changes in a CFD model, the company can save large sums of money that might otherwise have gone toward costly changes in the facility or increased cooling expenses, which can mount over time.

To be sure, CFD modeling requires an initial investment that can vary in expense depending on such factors

as whether the company is buying or renting a CFD software package or is simply hiring a firm to undertake the modeling effort. Although software may have a lower price tag, it can nevertheless cost tens of thousands of dollars (if not more) for just a single-seat license. Different CFD modeling packages also have different features and performance levels. Hiring a design services firm may or may not cost more, depending on the size and scope of the data center design being considered. Because CFD modeling requires careful and correct selection of the size and shape of the volume elements used to describe the data center layout (the size and shape of the volume elements must also, in all likelihood, be varied at certain locations to avoid spurious results), contracting out design work to experienced professionals may better suit companies who lack such expertise in house. In addition, depending on the complexity of the model, vast computational resources may be required to produce results in a reasonable amount of time. In either case, however, whether the company uses its own employees and facilities to model the data center design or hires a design firm to do the work, CFD modeling provides a rigorous method of analyzing the design before construction or before making changes to an existing facility.

Comments (0)