Data center cooling efficiency

Help reduce energy consumption and costs while extending equipment life

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Introduction

Data centers are consuming more energy as computing power and storage requirements continue to grow. To keep up with this trend, organizations need to build more efficient data centers that can better accommodate capacity demands, environmental considerations and growing energy costs.

Historically, the cooling system of the data center—especially the chiller— requires a significant amount of energy to operate. But in order to remain competitive and support green IT initiatives, organizations need to develop a strategy to cut costs while doing more with less. However, balancing these requirements can be challenging.

"Cooling is one of the largest costs of operating a data center, and it has a potential impact on the environment."[1]

This white paper examines three facts that influence data center cooling efficiency decisions. It then describes IBM's patented cooling process, which involves two separate systems—one for sensible heat and one for data center pressurization, fresh air make-up and humidity control. By designing the cooling system in a more efficient way, our process helps you reduce energy consumption and costs in the data center, while reducing maintenance requirements and extending the life of your equipment.

Fact 1. The chiller consumes a large amount of power.

The cooling system is part of the mechanical system of the data center and helps keep the data center at a low temperature to prevent IT equipment from overheating. Chillers consume a large percentage of electricity by generating chilled water for the heating, ventilating and air conditioning (HVAC) units. Many organizations are facing pressure to make their data centers more energy efficient. However, despite increased energy demands, budgets remain relatively unchanged.

A possible approach is to exchange the chiller for a newer and more efficient model to help improve energy efficiency. However, IBM suggests a different approach. Our patented cooling process uses a more holistic method that can address chiller power consumption as well as the entire mechanical system power consumption.

Fact 2. Data centers may operate outside ASHRAE-recommended thermal guidelines.

Summary of findings by ASHRAE.[2]

ASHRAE is an American non-profit organization promoting energy conservation and HVAC optimization through the Technical Committee (TC) 9.9. TC 9.9 is formed from nearly all the major IT manufacturers and has developed IT environmental thermal guidelines. The goal of TC 9.9 is to provide guidance to data center operators on maintaining high reliability and operating their data centers in a more energy-efficient manner. In a 2011 revision to the standards, participating major IT manufacturers unanimously agreed to the following recommended thermal guidelines for IT equipment.

Low-end temperature	18°C (64.4°F)
High-end temperature	27°C (80.6°F)
Low-end moisture	5.5°C dew point (DP) (41.9°F)
High-end moisture	60% relative humidity (RH) and 15°C DP (59°F DP)

The TC 9.9 committee recommends that air inlet temperature to the server should be between 18°C and 27°C. Note the range is identified as a *recommended* zone and not a *required* zone. This is because the IT equipment is capable of operating outside the recommended zone and this does not portray the absolute limits of inlet air temperature and humidity for IT equipment. The TC 9.9 committee also elaborated on the "allowable" temperature envelope depending on IT equipment classes.

In other words, the data center operator should try to stay as close as possible to the recommended envelope (18°C to 27°C) but can also consider that their IT equipment can run in the allowable zone without an adverse effect on the reliability, which is also affected by environmental class definitions. For instance, Class A1 equipment—which are typically part of a data center with tightly controlled environmental parameters, such as dew point, temperature and relative humidity—can operate up to 32°C. Meanwhile, Class A4 equipment—which is characterized by some control of environmental parameters—can operate up to 45°C. Some data center operators choose to always operate their IT equipment in the allowable zone. It should be noted that running IT equipment in an allowable zone for an extended period of time may have an effect on the IT equipment life span, which should be evaluated and calculated. Operation in the allowable zone can provide a substantial energy savings.

A good compromise may be to run the IT equipment in the recommended zone, while providing the opportunity to float into the allowable zone for common reasons such as energy reduction or cooling equipment failures. Data center operators typically know if their equipment is designed to support those conditions.

Fact 3. Data center equipment generates sensible heat only.

Many data center cooling systems are designed using office building cooling concepts. However, data center cooling requirements are considerably different than office building requirements. For example, the data center heat load is sensible heat (dry heat, no humidity) because of the low number of required people in the space and the low requirement of the fresh air make-up in comparison to the heat load of the IT equipment.

Considering this fact, tailoring the data center cooling system to the data center needs can improve energy consumption and can provide a better environmental control.

The IBM solution

Experienced IBM engineers have developed a patented concept that is adapted to operate the data center in accordance with the latest ASHRAE environmental guidelines that can reduce the chiller energy consumption and extend the life expectancy of the cooling systems. This concept is adaptable to operating the data center within the recommended zone as well as within the allowable zone.

The IBM patented cooling concept considers the three facts discussed in this white paper, and brings the data center design to a new era. IBM's concept uses two different cooling systems. One system handles sensible heat (IT load) and the other system controls the data center pressurization, fresh air make-up and humidity control. The concept is that by dealing with sensible and latent heat separately, it can reduce condensation and the humidification needs as well as the number of hours that the chiller will be required to operate. This helps reduce the energy consumption and required maintenance of the equipment, while also increasing the life expectancy of the equipment.

This IBM patented cooling concept has been in operation for more than two years at our new IBM Client Center (ICC) in Singapore. The power use effectiveness (PUE) (which includes all components as stipulated by The Green Grid Institute) is under 1.4. Additionally, the Singapore climate is the most stringent climate for data center operations, referred to as climate 1A (hot and humid) according to ASHRAE. In this type of climate, the potential for free cooling is out of the question. Our design allows the air conditioning system to operate more efficiently, for an improvement of up to 22 percent system efficiency.[3]

In a cooler climate condition, the patented design can increase free cooling from 30 percent of the time (or 2,628 hours) to 80 percent of the time and 7000 hours.[4]

This concept helps bring considerable savings in term of energy consumption while also helping to reduce the maintenance requirement and extend the life of the equipment. Also, the reliability of the facility can be improved by reducing the need for equipment maintenance—for example, extending the life of the air-handling units—and potential mishaps from human error. As with any equipment replacement, risk of data center failure or shut down may occur.

Conclusion

The new IBM patented cooling concept is a design differentiator and addresses concerns raised in the three facts, including energy cost, thermal guidelines and sensible heat generation. The IBM solution can help you create a state-of-the-art data center that is designed to be more efficient, reliable and easier to operate and maintain. This cooling concept demonstrated reduced capital cost when compared to traditional cooling systems.

IBM owns and manages more than eight million square feet of data centers and can draw on our years of cumulative expertise to help your organization reduce data center energy and operating costs.

For more information

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Global Services
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Produced in the United States of America
December 2015

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[1] Gartner, Hype Cycle for Data Center Power and Cooling Technologies, 2015. Jay E. Pultz. July 20, 2015. G00277271.

[2] ASHRAE TC9.9."2011 Thermal Guidelines for Data Processing Environments – Expanded Data Center Classes and Usage Guidance." 2011.

[3] Based on IBM internal data.

[4] Ibid.

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BUW03052-USEN-00