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В докладах представлены результаты теоретических и экспериментальных исследований, практических внедрений, проведенных в Казахстане, Дании, Бельгии, Германии, России, Японии, Узбекистане и Украине по следующим направлениям: холодильные машины и установки, системы кондиционирования воздуха и жизнеобеспечения, экология в холодильной промышленности, холодильная и пищевая технология. Сборник рассчитан на специалистов и ученых, работающих в областях холодильной, пищевой, химической, нефтеперерабатывающей промышленностей, а также на специалистов по системам кондиционирования воздуха и жизнеобеспечения жилых, коммерческих зданий и спортивных комплексов.

The proceedings present the results of theoretical and experimental studies, practical implementations in Kazakhstan, Denmark, Belgium, Germany, Russia, Japan, Uzbekistan and Ukraine in the following areas: refrigeration machines and installations, air conditioning and life support systems, refrigeration ecology, refrigeration and food technology. These proceedings are devoted to professionals and scientists working in the fields of refrigeration, food, chemical, oil refining industries, as well as to specialists of air conditioning systems and life-support of residential, commercial buildings and sports complexes.

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шей энергетической эффективности и вносит меньший вклад в глобальное изменение климата (≈ на 22%). Выбор альтернативного оборудования по двум анализируемым критериям (влияние на истощение природных ресурсов и вклад в глобальное потепление) будет способствовать реализации закона об энергосбережении и Киотского протокола (направленного на снижение эмиссии парниковых газов). Общее экологическое воздействие для традиционной системы так же больше, чем для альтернативной, что еще раз подтверждает преимущества последней. Полученные результат показывают, что наибольшее воздействие на окружающую среду производится во время эксплуатации системы. Причем наибольшее влияние в этот период связано с энергопотреблением СКВ.

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УДК 627

ENERGY-EFFICIENT SYSTEM DESIGN FOR THE DATA CENTER COOLING AND HEATING WITH REDUCING ENVIRONMENTAL IMPACT

РАЗРАБОТКА ЭНЕРГОЭФФЕКТИВНОЙ СИСТЕМЫ ДЛЯ ОХЛАЖДЕНИЯ И ОТОПЛЕНИЯ ЦЕНТРОВ ОБРАБОТКИ ДАННЫХ С СОКРАЩЕНИЕМ ВОЗДЕЙСТВИЯ НА ОКРУЖАЮЩУЮ СРЕДУ

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Abstract

The environmental impact and energy use of data centers has become a significant issue for operators, HVAC systems developers, energy and environmental policy makers. We emphasize the impact of macroeconomic risk and business cycle fluctuations in shaping public attitudes toward climate change and more general aspects of environmental policy. The scope of this study is energy efficiency analysis of Computer Room Air Conditioning (CRAC) system. Benefits of various conventional and new hybrid refrigeration systems for server rooms were evaluated. Operation modes of suggested system was analyzed for South Ukrainian region (Odessa). Estimated power usage effectiveness (PUE) was estimated and electricity costs with suggested system can be reduced by 45%.

Аннотация

Для операторов, разработчиков систем ОВК и разработчиков политик в области энергетики и охраны окружающей среды в настоящее время значительными проблемами являются воздействие на окружающую среду и потребление энергии центрами обработки данных. Целью настоящего исследования является анализ энергоэффективности системы кондиционирования для компьютерного зала. Были оценены преимущества различных традиционных и новых гибридных холодильных систем для серверных комнат. Были проанализированы режимы работы данных систем на территории Юга Украины (г. Одесса). Было определено оценочное потребление энергии и установлено, что с предлагаемой системой стоимость потребленной электроэнергии может быть сокращена на 45%.

The environmental impact and energy use of data centers has become a significant issue for operators, HVAC systems developers, energy and environmental policy makers. We emphasize the impact of macroeconomic risk and business cycle fluctuations in shaping public attitudes toward climate change and more general aspects of environmental policy. As policy makers have defined information technology, data center energy use as the fastest rising sector from other once, data centers represent easy target due to the very high density of energy consumption. In own turn the commodity price of energy has risen faster in comparison with expert prognosis. Such type of energy cost rising has significantly impacted the business models developed for data center operators and has determined changes in the way data center capacity is charged for commercially. Energy security issue as well as energy availability are also fast becoming an key point for energy strategy development of data center operators as the combined pressures of fossil fuel availability, generation and distribution infrastructure capacity and environmental energy policy make prediction of energy availability and cost difficult.

System Requirements

In the basic significance heat gains are heat gains from rack. Other heat gains have not taking into account. We are use 36 pieces of server and telecommunications racks (or 1512U). The calculated amount of racks with the equipment is equal 24.7 racks (1038U). Heat generation by equipment are equal 404.6 kW. Amount of empty racks for future equipment are equal 11.3 rack (474U). Average of rating calorification by one rack is equal 16.4 kW, so we need reserve of cooling capacity in amount 11.3*16,4=184.8kW. Required cooling capacity = 590kW.

Technical solution.

Computer room air conditioning (CRAC) system must provide constant temperature and humidification conditions for communication and telecommunication servers and other technical systems in the server room. Air-conditioner must provide air circulation within the principle of a dividing hot and cold aisles by method of deliver cold air to servers by pressurized in the space below the raised floor and returned warm air below the ceiling. This principle shows on the figure 1

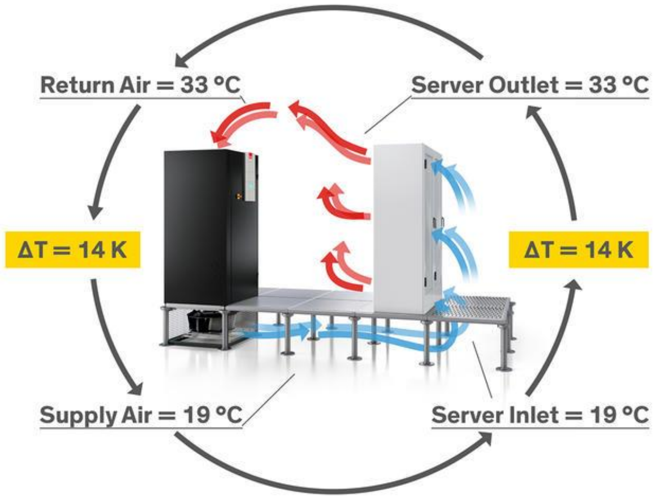

Figure 1 – Air circulation principle

For assimilation heat gain from technical equipment "Stulz" air condition system was used (model CyberAir 3PRO ALG 722 GE). Arrangement inner condition modules provide availability for hot and cold aisles of air. CRAC keep constant temperature and atmospheric moisture capacity. The chosen system was provided with DFC technology (Dynamic Free Cooling). It is the first precision air-conditioning system in the world that automatically switches to the best operating mode depending on the heat load in the data center and seasonal variations in ambient temperature. Full hybrid with Indirect Free Cooling DFC combines compressor cooling and Free Cooling in four stages in all, and automatically searches for the most economical operating mode. In cool weather, DFC makes use of economical Indirect Free Cooling, which extracts all its cooling power from the ambient air. Energy-intensive compressor cooling (DX) is only switched on when absolutely necessary.

With utmost sensitivity and precision, DFC selects the most energy-saving mode, controls the speed of the EC fans in the A/C unit and those of the dry coolers, regulates the position of the control valves, reduces the electricity consumption of the pumps and ensures interior climate control. By incorporating standby units as well, DFC keeps all units, pumps and dry coolers in perfect balance in energy-saving partial load mode.

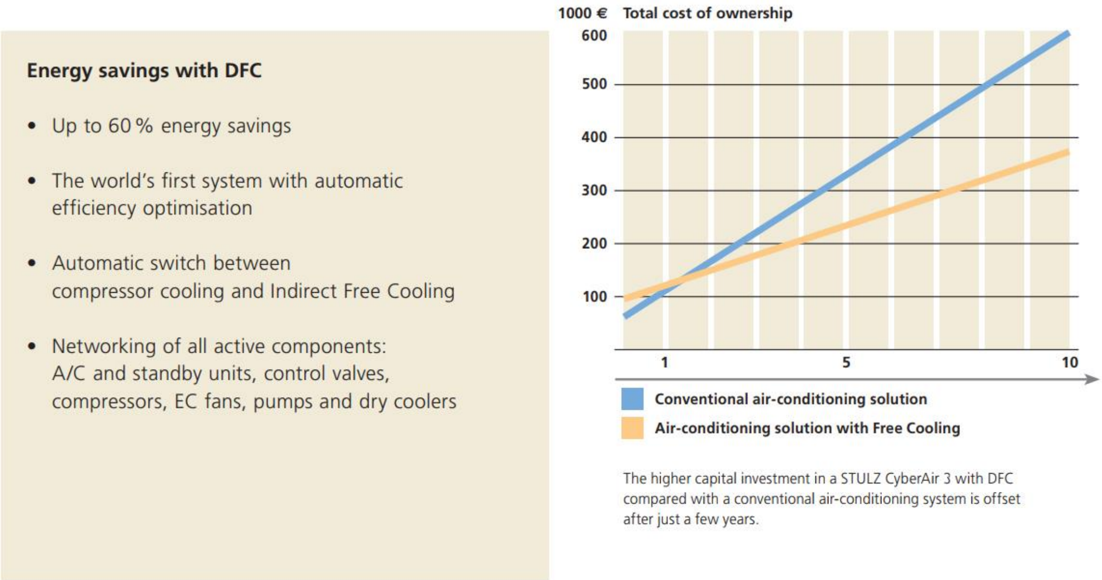

Figure 2 – Comparison of dynamic cooling mode with conventional CRAC system

The DFC system - individual A/C units work in perfect harmony with Indirect Free Cooling. Each A/C unit works with a DX refrigerant circuit comprising an evaporator, electronic expansion valve (EEV), scroll compressor and brazed plate condenser - and a separate chilled water circuit for use of Indirect Free Cooling. The mechanical switchover from DX to Indirect Free Cooling mode is achieved steplessly by means of 2-way valves.

When room air flows through the heat exchanger in DX mode, the heat is transferred to a refrigerant, and emitted into the ambient air via a pipe system leading to an external dry cooler. Both the A/C unit and the dry cooler are equipped with EC fans with stepless control. Speed-controlled pumps are used in Free Cooling mode to supply the water/glycol mixture.

Table 1 – The equipment placement:

Equipment type	Parameter
–ALR 722 GE (7 pieces) –GCHC RD 050.1/22-41-4227657M (18 pieces)	
Air parameters in the room: – operating-temperature range, °C – relative humidity, %	 +19…+33 30
Ambient temperature range, °C	- 40…+40

DFC controls all the components of the air-conditioning system with precision and always selects the best possible operating point, ensuring an optimum supply of cold air in the data center.

Table 2 – Characteristics of the CRAC system

Name	Units	Value
DX-Cooling capacity by temperature: – Server outlet air – Server inlet air	kW °C °C	89,9 33 19
Air consumption	m^3/h	19300
DX-Cooling capacity(total)	kW	89,9
CW- Cooling capacity by temperature: – Server outlet air – Server inlet air CW- Cooling capacity(total)	kW °C °C kW	96.6 33 19 96.6
Fan: – Fan power consumption – supply voltage /amount phase/ frequency – Fan amount	 kW V/ph/hertz piece	 2.8 380/3/50 3
Steam humidification: – Power consumption – supply voltage /amount phase/ frequency – Amount	 kW V/ph/hertz piece	 2 380/3/50 3
Filter class		F5
Overall dimensions	mm	945x2550x2496
Water consumption	m^3/h	9,6
Weight	kg	1104

Direct expansion system

Compressor cooling system based on the direct evaporator principle (DX/direct expansion). The refrigerant circuit of the air conditioning module consists of an evaporator, an expansion valve, a scroll compressor and an external air-cooled condenser.

The outside air conveyed by the fan flows through the evaporator. As it does so, heat is removed from the air and is transferred to the refrigerant. The air conditioning unit and the external condenser are linked by means of a closed refrigerant circuit.

Simple heat dissipation via the water-glycol mixture

In this type of system, the heat from the DX circuit is transferred to a water-glycol mixture by a plate-type condenser integrated in the air conditioning unit. The mixture circulates in a closed circuit, and emits the heat to the outside air via an external dry cooler.

Hybrid system with Indirect Free Cooling

A hybrid cooling system, which combines DX system and system with Indirect Free Cooling. This type of system switches to energy-saving mode as soon as the outside temperature permits. The outside air is then utilized for Indirect Free Cooling.

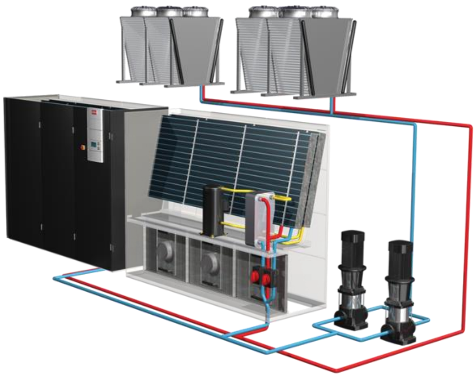

Figure 3 – Hybrid refrigeration system

Analysis

Power usage effectiveness (PUE) is a metric used to determine the energy efficiency of a data center. PUE is determined by dividing the amount of power entering a data center by the power used to run the computer infrastructure within it. PUE is therefore expressed as a ratio, with overall efficiency improving as the quotient decreases toward 1. PUE was created by members of the Green Grid, an industry group focused on data center energy efficiency.

Table 3. Gradation of PUE

$$\text{PUE} = \frac{\text{Total Facility Energy}}{\text{IT Equipment Energy}}, (1)$$

PUE	Level of Efficiency
3.0	Very Inefficient
2.5	Inefficient
2.0	Average
1.5	Efficient
1.2	Very Efficient

Information, telecommunication and engineer’s systems are functional parallel. Useful IT-function realize for user is the first two. Engineering infrastructure is providing a possibility safe and reliable operation the first two. By calculation, the precision cooling Air system has PUE equal 1.88 in period when temperature higher than 19 °C and equal 1.13 when temperature lower than 17 °C. For example, was took comparison precision air cooling and liquid systems.

System liquid cooling is more efficient then air cooling and must fundamentally reduce operation costs. ASHRAE Technical Committee 9.9 (TC 9.9) has done considerable work in the area of determining suitable environments for ITE. They were found that for about 40% of all electricity in data center use for cooling system, in which 30% use compressor.

By change precision air cooling on liquid cooling technology can reach next operate benefits:

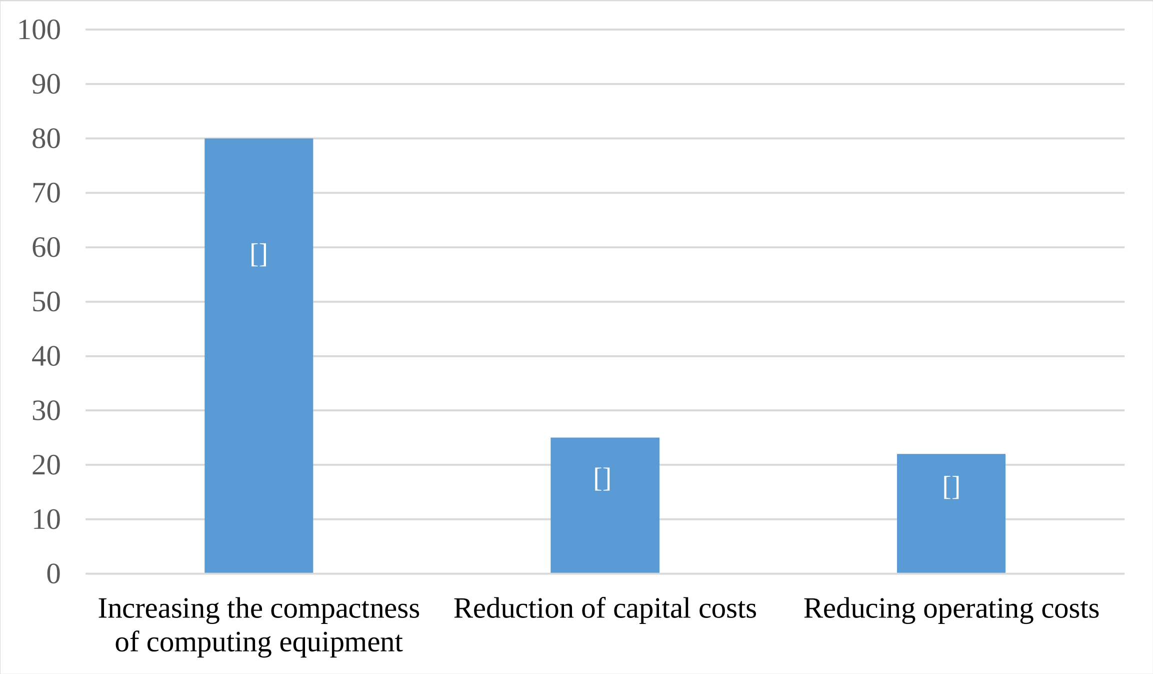

Figure 4 – Comparison of possible benefits

Greater compactness of computing equipment - less space need for placed equipment. For reduction of capital costs some infrastructure system should be abandoned. So if part of equipment is gone, without reducing the power of the system, it reducing of all electricity using.

The benefits of precision air cooling:

–Precise and quick processor-based temperature control, to keep your IT equipment at the right temperature, always.

–Precise humidity control. Electronic devices require a steady level of humidity for proper functioning. Both high/low humidity levels can impede them on the long run.

–Designed for 24 x 7, 365 days continuous operation.

–Precision air conditioners are designed to manage high levels of sensible heat (heat without humidity, emanated by machines)

–*The benefits of liquid cooling:*

–Less clutter and more space

–The heat absorption rates of liquids are far greater than that of air. For example, it takes just a few gallons of water to absorb as much heat as would be absorbed by a far greater quantity of air.

–Liquids can transport heat more efficiently and can transport heat away from all parts of the data center, thereby maintaining a sustainable operating environment within the data center.

–Liquid cooling allows targeted cooling, which is nearly impossible to achieve with air cooling. It is possible to cool a targeted area (high density cabinets, cooling within servers) using liquid cooling more efficiently.

–A moving fluid extract heat way better than a non moving fluid

–Turbulent flow requires more energy to be moved but extract heat way better than laminar flow. If you compare water and mineral oil versus air (for the same volume) mineral oil is around 1500 times better than air water is around 3500 times better than air oil is a bad electricity conductor in all conditions and is used to cool high power transformers.

–Oil depending on its exact type is a solvent and is able to dissolve plastic

–Water is a good conductor of electricity if it is not pure (contains minerals...).

–Water is a good electrolyte. So metals put in contact with water can be dissolved under certain conditions

Disadvantages: liquid cooling:

The main disadvantage to this kind of cooling system is serviceability, since the liquid does create an obstacle to quickly changing components out or performing other forms of hardware maintenance. Each time the system needs to be serviced, the liquid must be removed and the components dried for handling.

Hybrid systems that encase individual servers may help mitigate this issue without decreasing efficiency, but the increased cost of setup complicates things.

Conclusions

Dynamic free cooling provides benefits of fresh air-cooling using more common chilled water loop technologies and can present major retrofit opportunities. An intelligent control system to optimize the use of free cooling in a chilled water based system can be used. When it is necessary for lowering heat loads the free chilled water can be run to the CRAC units at a higher temperature than in a conventional system requirements at the same time as still achieving the required cooling, this significantly extends the external temperature range through which the facility can operate on the free cooling coils. When the heat load in the facility or the external temperature exceeds the thresholds then the compressor pumps are started and the system reverts to normal operation.

The other significant environmental impact on data center efficiency is direct insolation (incoming solar radiation) heating to the building. This varies by time of day, season and geographic location from 1,04 kW /m2/day in in Odessa in January to 6,04 kW /m2/day in July. This can become a significant contribution to the peak cooling loads of the data center for those with relatively low power densities and a low albedo (proportion of incident sunlight reflected). Careful positioning and orientation of the building and the cooling equipment can assist in reducing these insolation loads.

To achieve the best level of HVAC system reliability, you need to employ required procedures and safety measures. Historically in datacenters, all of the procedures are developed for air cooling systems and water is restricted to its safest use if not banned from datacenters. Basically, it is impossible for water to ever come into contact with servers.

The typical data center general electricity costs can be reduced to 45%, 25% less implementation costs vs air, PUE of 1.04 by using the liquid data center immersion cooling solution. Technically water is better, but server design and datacenter designs are not adapted to water cooling.

УДК 639.64.1

INVESTIGATION OF PLANT ORIGIN DIETATIC SUPPLEMENTS COMPOSITIONS PROPERTIES

ИССЛЕДОВАНИЕ СВОЙСТВ КОМПОЗИЦИЙ ПИЩЕВЫХ ДОБАВОК РАСТИТЕЛЬНОГО ПРОИСХОЖДЕНИЯ

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Abstract

On the basis of theoretial and experimental studies it is proved that dietary plant additive compositions must be used to provide specified effects of gero-dietetic food products. It is estimated that moisture absorbing properties of dietetic plant additives remain stable and high (450-