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IMPROVING ENERGY EFFICIENCY OF DATA CENTRES

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Abstract: Great energy consumption and costs incurred by data centres are a huge incentive to find ways to reduce them. In a typical data centre, nearly one half of the energy consumed goes to supporting data-com equipment, and the other half is used by support systems. Hence, increasing the energy efficiency of data centres is a challenge. This paper discusses the possibilities for improving the energy efficiency of air conditioning systems and ventilation by integrating best tested devices, with special emphasis on the management and control system for air conditioning and ventilation.
Keywords: data centre, control system, energy efficiency, conditioning and ventilation

INTRODUCTION

The air-conditioning system should provide ventilation, filtration, cooling and dehumidification, humidification and heating of the air; to operate continuously throughout the year and to be flexible if an expansion is required without interrupting the operation of the data centre. Its work, servicing and maintenance, must not disrupt the operation of the centre.

The system of ventilation and air conditioning (HVAC) which maintains the foreseen operating conditions of the equipment in the data centre which consumes on average 38% of the total energy consumption in the data centre (Fig. 1). From that perspective, the design of control system for air conditioning and ventilation which achieves fast response and reliable operation is the best way to achieve energy-efficient control and reduce the cost of HVAC system.

MANAGEMENT AND CONTROL OF THE AIR-CONDITIONING AND VENTILATIONSYSTEMS

A well-designed and maintained control system for air-conditioning and ventilation in data-com centres has a significant impact on energy costs of HVAC system. When designing the control system, the goal is to design energy-efficient control solutions which optimize energy consumption, without causing any risk for the Data Centre. The control system must continuously provide working conditions in Data centre according to the Thermal guidelines ASHRAE 2004, and its task is to secure the operation of the equipment for air conditioning and ventilation work in sequences or phases which are necessary to maintain the operating conditions of the data com equipment 24 hours a day, seven days a week.

The most efficient HVAC system is the one that always complies with the needs for data equipment cooling. Using intelligent cooling control systems with the air conditioning and ventilation the cooling capacity and the cold airflow is adjusted to the current conditions in the data centre, simultaneously carrying out a coordinated management of refrigeration unit works, which is of essential importance in optimizing the efficiency of the system.

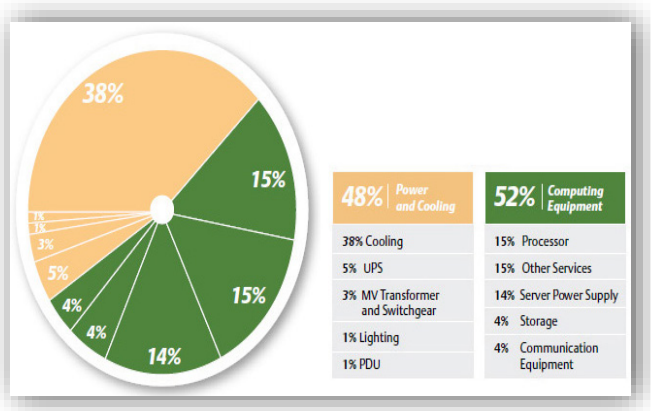

Figure 1. Data-com equipment accounts for over 50% of the energy used while power and cooling account for an additional 48% in a traditional data centre

Efficient operation and saving measures for air conditioning system and ventilation are achieved

through its components: air distribution control in the data centre, managing the air conditioning loop, control of the outside air, controlling the work of the economizers, the humidity control, the part-load operation, etc.

» **Increasing the efficiency of the fans**

The fans are components of the cooling system which consume significant amounts of energy. By increasing the efficiency of the fans the efficiency of the air conditioning system of the data centre is increased. Using variable frequency drives significantly reduces energy consumption compared with fixed-speed fans. The addition of variable frequency drives to the fan motors enables fan speed and power to be reduced inconformity with the reduction of the load. 20 percent reduction of fan speed allows almost 50 percent savings in the fan power consumption.

The use of electronically commutated fans makes possible the increase of the cooling unit energy efficiency. Electronically commutated fans are more efficient than centrifugal fans, because they eliminate the zone of losses, which runs up to about five percent.

» **Reduction of cooling unit working hours**

The cooling unit is the largest energy consumer of all HVAC equipment in the centre. Significant energy savings can be achieved by reducing the working hours of the cooling unit. It requires the installation of structural elements in the design of the cooling system, especially in centres that consume large amounts of energy. Besides the use of equipment with greater energy efficiency in the cooling system, a method of reducing the working hours of the equipment should be incorporated. Therefore whenever the conditions allowed free cooling- option should be used. Both types of economizer which can reduce the working hours of the cooling device are the following: the air-side economizers and the fluid-side economizers (often called water-side).

Economizers achieve major savings in areas where temperatures are lower, but if properly designed, they can achieve significant savings also in warmer climates. The system of economizers using outside air provide “free-cooling” cycles. This reduces or eliminates the work of the chiller and the operation of the compressor in the precision cooling units, allowing the economizers` system cooling unit to generate savings from 30 to 50 percent, depending on the average temperature and humidity of the environment.

A fluid-side economizer works in conjunction with a heat rejection loop comprising an evaporative cooling tower or dry-cooler to satisfy cooling requirements. It uses outside air to aid heat rejection, but does not introduce outside air into the data center.

» **Air distribution control system**

The right solution and control system for air distribution in data centres is one of the major factors for achieving the prescribed conditions for the data centre or the data-com equipment. To provide effective cooling the air distribution has to be appropriate to the thermal load. The distribution systems should be sufficiently flexible to be able to adapt to changes and to sizes of thermal loads. The flexibility and reserves can be achieved using the system of distribution with variable air flow (VAV), by introducing oversized systems, by cross-linking of complex systems, and by providing equipment which does not operate and is in working condition. Using a system with variable airflow and its proper control can be provided if additional capacity is ensured if necessary, and the system will work with values of the temperature and air flow which are suitable for the regulation of the optimum temperature and humidity in the data centre simultaneously reducing the energy consumption for fan operation, and the need for additional heating.

» **Managing the air conditioning loop**

Especially significant is the appropriate choice of the heated air flow paths, and its discharge from the data centre. The recirculation and mixing of the heated discharged air and cold supply air, negatively impact the achievement of the necessary work conditions of data-com equipment. The short circuit of the cold air (its untimely return to the air conditioning system) without passing through releasing heat data-com equipment, can significantly affect the performance and energy efficiency of the air conditioning equipment. It is recommended to apply date equipment in hot / cold aisle arrangement in order to reduce the mixing of cold supply air and warm air return. This date equipment arrangement contributes to the temperature increase of the supplied cold air in the room, that is, makes it easier to achieve the recommended (ASHRAE guidelines 2004). The aim is to ensure an adequate supply of cold air to the front of the data-com equipment, i.e. in the cold aisles and the removal of hot air, which is discharged at the rear of the equipment, to wit, off the warm aisles. Typical data centres have high thermal loads, and despite the hot / cold aisles arrangement of the equipment, a part of the warm air flows towards the cool aisles, making it difficult to maintain the designed data equipment working conditions. Therefore it is essential to separate the cold from the warm air, and its discharge into the air-conditioning equipment.

The physical barrier separating the warm from cold air is necessary in order to maximize the scope of separation. Anyone of the following three approaches - partition of the cold aisle, of the hot aisle and of the rack- could provide a physical separation, whereby each of them has its advantages and limitations.

Partitioning of the cold aisle allows cold air containment in the individual aisles, by means of physical barriers on the upper part and on the sides of the aisles. The barrier prevents mixing of warm air at the outlet from the data equipment with the cold air, thus providing a uniform temperature at the inlet to data equipment. The supplied air temperature can be reset to a higher value because the inlet air temperature to data equipment will be equal to that of the supplied air. The increased temperature of the supplied air will yield greater working efficiency of the cooling devices and will increase the free cooling time. Of course, the required amount of airflow will also be reduced leading to lower direct energy consumption for air recirculation. For high-density data centre a full enclosure of the cold aisles is recommended, making it easier to achieve the cooling capacity matching the thermal load of the data equipment.

In the warm aisle partition design, the whole data centre save the cold aisles, is exposed to the hot air from data equipment, and is approximately with the same temperature as the temperature of the discharge air at the outlet from the data equipment which is usually higher 11 to 22°C than the inlet air temperature to data-com equipment. Therefore, the need for containing the warm air within the warm aisles, and to open the rest of the data centre to the supply of cold air.

The partition of the racks is similar to the partition of cold and hot aisles, but it is implemented in the individual racks. The partition of the racks provides special paths for the entry of cold air and the discharge of hot air, thereby hindering the mixing of warm and cold air. The partition of the racks has its advantages, since the rack is the smallest unit in the data centre which can be placed anywhere, without strictly observing the need for hot/cold aisles arrangement.

Another possibility is the overheat space to be used as a plenum for hot air, wherefrom the warm air flows back towards the air conditioning units.

» **Control of outdoor air**

In order to control the pressure and humidity in the premises of the data centre, it is necessary to install a system for control of the outside air. The main moisture load usually comes from infiltration, therefore the employed system for supply of external air brings premises in a pressurized condition, thus preventing the infiltration of outside air, as well as meeting all the requirements for humidification and dehumidification exerted by it.

» **Part – load operation control**

To develop an effective control of part- load operation sequence for the central cooling plant it is particularly important due to the oscillation of the thermal loads in the Data Centre.

The part load operation of the data centre offers considerable energy savings due to reduced and more efficient compressor operation, either in the plant with cooling water or in the special cooling units. When choosing the cooling devices for Data centres it the operating range in which they will work should be borne in mind, taking into account working with duplicated cooling devices, and the fact that the cooling devices will often work with low capacity although they are dimensioned to match peak loads in the data centre.

CONCLUSION

Although security in the operation of data centres is a priority, significant energy reductions can be achieved without thereby reducing the reliability. Significant energy savings can be achieved by carefully implementing the free cooling plants and variable frequency drives by controlling the air-distribution system in the data centre, by managing the air conditioning loop, by controlling of the outside air, by regulating the work of air and fluideconomizers, and by monitoring the humidity and part-load operation.

Note

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REFERENCES

[1] Martin M., Khattar M., Germagian M. (2007): High - density heat containment, ASHRAE Journal, pp. 38-43.
[2] ASHRAE Technical Committee 9.9: (2004). ThermalGuidelines for Data Processing Environments. ASHRAE, AtlantaGA.
[3] ASHRAE Technical Committee 9.9: (2008). HVAC Controls and Energy management.Best Practices for Datacom Facility Energy Efficiency. ASHRAE, AtlantaGA, p. 85-96.
[4] ASHRAE Technical Committee 9.9: (2008). Computer Room Cooling.Design Considerations for Datacom Equipment Centers. ASHRAE, Atlanta GA, p. 23-34
[5] A White Paper from the Experts in Business – Critical Continuity, Seven BestPractices for

Increasing Efficiency, Availability andCapacity: The Enterprise Data Center DesignGuide, www.emersonnetworkpower.com/documentation/en.../sl-24664.pdf
[6] Sevde Stavreva, Cvete Dimitrieska, Igor Andreevski, Sanja P. Vasilevska, Elizabeta Hristovska, Improving energy efficiency of data centres, The 12th International Conference on Accomplishments in Electrical and Mechanical Engineering and Information Technology – DEMI 2015

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