

The Harmonious Development among Architecture, Environment and Energy Source based on the Air Conditioning Industry

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Abstract: This paper analyses the effect on the architecture technology and the architecture style along with the development of AC (Air Conditioning) industry. It divides the environment into interior environment and exterior environment, indicates the influence on the exterior environment while using AC to improve the interior environment, whereas, also analyses the influence on the AC system form and performance by the exterior environment. Take the energy consumption into account, it emphasizes the technology requirement and several kinds of energy conservation method for the AC industry. Based on the environmental protection and society evolution, it summarizes the development trend of future architecture.

Keyword: AC industry, architecture, interior environment, exterior environment, energy consumption

1. INTRODUCTION

While enter into 21st century, the development of the technology drives the rapid development of various industry. As to China, along with the great development of economy, there are great requirement of energy and environment, especially for building energy consumption. The building has the demand of desirable environment, including heat, light, sound, and air environment. As the effective instrument for improving the indoor heat and air environment, the AC (air conditioner) has the extensive application. But in the other hand, it also bring the problem of energy consumption and serious environment pollution. The building energy consumption increased year by year, has achieved to over 35% of the total society energy consumption. The AC energy consumption get to 55~65% of the building energy consumption.^[1] Because of the energy crisis, as to AC system, it demands for less energy consumption. It pursue for high energy efficiency and better adiabatic effect of building. It leads to airtight building and worse ventilation effect. Along with the large quantity using of synthetic, as the building material and decorate material, all of these result in indoor air contamination accumulation and worse IAQ (indoor air quality). It is a threat to people's health. The problem that how to get the harmonious development among architecture, environment and energy source becomes emergency resolved. As to AC system, it should get the effect of energy conservation and environment protection.

2. ARCHITECTURE AND ENVIRONMENT

The building technology has developed along with the technology developing. The building becomes

higher and has more complete function. It saves the ground space and centralizes the function. There are lots of equipments to improve the interior environment. In a certain extent, it can ensure the comfort interior environment. But in the other hand, it also bring kinds of problem.

2.1 Influence on the exterior environment of development of the building technology

The development of building technology mainly embody in the city building. It needs a large amount of material and energy in the building development. It also brings noise and air pollution in the course of building. The concentrated buildings leads to urban heat island (UHI). In the center of a large city, the average temperature is higher than the suburb average temperature by 2~3℃. It is a course that the AC satisfy the interior environment with the way of damaging the exterior environment. It intensifies the UHI. The use of Freon as the AC refrigerant causes the problem that the ozonosphere becomes thin. It is a threat to earth biology. As a part of the AC system, the cooling tower could bring LD (Legionellae Disease) problem on the local environment. The water in the cooling tower is good place for the bacteria that called Legionellae growing. The bacteria can easily diffuse to the air along with the fog. It could cause the LD while the bacteria inbreathed. The AC system could bring on noise while operating.

2.2 Influence on the interior environment of development of the building technology

In the light of energy conservation, the building pursue for high energy efficiency and better adiabatic effect. But in the other hand, it cause the worse ventilation and less air circulation ratio. As to tall

building, the interior environment is completely controlled by manual work, including sound, light, heat and airflow field control. Along with the development of the architecture industry and high quality life requirement, people pursue for beautiful in the room and a large amount of synthetic have been used for decorate. These lead to accumulation of indoor air contaminant. People stay indoor over 80% of the time. All of these cause the SBS (Sick Building Syndrome). It is reported that the indoor air pollution is more serious than outdoor air pollution, always get to 2-5 times, even over 100 times. Therefore, the indoor air pollution has already been classified as one of five major factors which is detrimental to health.

The source of indoor air contaminant is classified to indoor source and outdoor source. The outdoor air contaminant mainly root in industry, traffic and secondary reaction production, such as benzene, sulfur dioxide, nitrogen dioxide, PM₁₀, ozone and so on. They enter into room by the way of air exchange between indoor and outdoor and by the way of penetration. It deteriorates the IAQ. The indoor air contaminant mainly root in smoking, fuel combustion, cooking smoke, the building decorate, the occupant activity and various furniture. It contains kinds of air contaminant, including formaldehyde, nitrogen dioxide, sulfur dioxide, R_n, PM₁₀, VOCs, microorganism and various combust production.^[2]

There are some kinds of building that have more rigorous demand on the indoor environment, such as office building, exclusive hotel, some special gymnasium, special technics factory. They have the demand not only on the temperature and humidity, but also on the indoor sound and light. The control of the temperature and humidity will bring noise pollution. The failing control of light will bring light pollution. Just like the noise pollution, the light pollution has serious harm on health and will waste the energy source.^[3]

3. ENVIRONMENT AND ENERGY SOURCE

There are contradiction between environment and energy source. It is a emergency problem. There is a trend that developing the clean, renewable energy, such as wind energy, solar energy, geothermal energy, tide energy. The energy use reduce the damage on the environment.

4. THE HARMONIOUS DEVELOPMENT AMONG ARCHITECTURE, ENVIRONMENT AND ENERGY SOURCE

4.1 The harmonious development between architecture and environment

4.1.1 The harmonious development between architecture and exterior environment

We can divide the relationship between architecture and environment into the relationship between architecture and exterior environment and the relationship between architecture and interior environment. The way to deal with the former one is the reasonable arrangement of building, sufficiency considering the influence on the nearby environment of the building. The improvement of exterior environment makes obviously influence on the architecture. Beside

of that, the exterior environment meteorological condition is the basis of AC design. The exterior environment makes influence on the AC load. The green plant around the architecture not only have the function of windproof, sound insulation, dustproof and decorate the environment, but also have the important function of heat insulation and energy conservation. The green plant can reduce the temperature of local climate, adjust and reduce the absorption of solar radiation, improve the temperature and humidity balance, reduce the AC load, achieve the building energy conservation.^[4]

4.1.2 The harmonious development between architecture and interior environment

The interior environment quality is more important than the exterior environment quality. The airtight of the modern architecture leads to a closed circulation among occupant, indoor air and AC unit. The closed circulation system leads to three disadvantages: the first is the air contaminant accumulation; the second is the propagation of the various microorganism, such as bacteriosis, virus, mildew; the third is the contaminant propagation of the air microorganism among rooms. The household air conditioner only just install the primary air filter.

The IAQ (Indoor Air Quality) means estimate of the influence on the occupant health and mentality of the various indoor environment factor. The basic way to improve IAQ is reducing the indoor air contaminant source, vast utilize the make-up system. According to the filtration technology, the filter in the AC system can divide into physical filter and chemical filter. The chemical filtration technology include: direct bactericide, adsorption, light catalyze and so on. The physical filtration technology include: anion method, static electricity method, ultraviolet method^[5]. But these method have disadvantage. It could be a satisfy effect that combining them. The future AC system sterilization technology is the filter net alteration, make use of the nanometer technology and the electromagnetism technology, achieve the technology optimizing configuration.

The completely improve the IAQ method include passive and initiative method. The passive method include overcome the solar radiate problem and the adopting of nature ventilation. The initiative method include the airflow rate tunable displacement ventilation system, the cooling ceiling system, the combination of ice thermal storage cold air distribution system and the dehumidification AC system.

4.2 The harmonious development between architecture and energy source

It's a great energy consumption that the interior environment completely manual control. Under the energy crisis circumstances, the building energy conservation is the basic direction and the strategy problem. The AC energy consumption is the crucial part of the building energy consumption.

4.2.1 Building energy conservation

The building structure energy conservation is the basis of the AC energy conservation. The building plane, orientation, the window frame and material, the overhang eaves are influent the building envelope AC load.

4.2.2 The traditional AC energy conservation method

The method that have been adopted since the mid-seventies still wide use, including the exhaust air heat recovery, ice thermal storage, heat pump, variable air volume system, variable water volume system, floor panel heating and cooling.

4.2.3 The internal and external dividing area of Large-and-middle-scale office building

Compared with the normal space distribution, this method could be more agility and reasonable. The external may make use of independent heat pump unit. The internal heat source may adopt the district heating and cooling system, central absorption refrigeration system. It's a energy conservation method that it adopt the enclosed water heat source unit heat pump, to consider the internal exhaust heat as the external heat source.

4.2.4 Un-distribute office building

The AC system adopt the new AC unit, including: (1) through wall unit, several this kinds of unit can supply fresh air and have exhaust air heat recovery unit. The TWU has the requirement on the building elevation; (2) Variable Refrigerant Volume. A outside machine could work with several inside machine. The compressor use the frequency control. The system can also install the exhaust air heat recovery make-up system.

4.2.5 The combination of background AC and personal AC

As to the intelligent office building, the building can make into the double floor while combining comprehensive wiring, achieve the similar displacement ventilation that is underfloor air supply. On this basis, the system could be designed to combination of background AC and personal AC. The personal AC could be controlled by human according to his comfort. The background AC parameter can turn down. This way is favorable to unify energy conservation and comfort.

4.2.6 The application of Zero Energy District

In the building with complete building energy conservation equipment, the interior air conditioning utilize the natural ventilation in summer and the passive solar energy heating in winter, let the indoor PMV value fluctuate in the permit range. In the designing of auto control of AC system, adopt a order control of heating, ventilation and cooling, establish the AC load automatically. In the transition season, utilize the ZEB control stop heating and cooling.

4.2.7 The method of application the electricity at night and avoid electric peak

While utilize the heat storage technology, the AC system can avoid the electric peak, alleviate the tense situation of city electric using. Because of the electricity price differential between daytime and night, the technology has enormous economic benefit. There are several kinds of heat storage technology, including the ice thermal storage, the high temperature phase change material thermal storage and the building material thermal storage. Certainly, the technology are not the energy conservation one, but they have economic benefit.

4.2.8 Direct use of the nature energy

(1) Application of the free cooling

① In the transition season, the AC system utilize the

fresh air as possible, can not only achieve energy conservation, but also improve IAQ; ② The nightpurge: reduce the indoor temperature by the way of natural ventilation at night; ③ Applying the cool water from the cooling tower for building internal cooling; ④ Utilize the cuniculus wind to reduce temperature.^[6]

(2) Application of the ground source heat pump

The GSHP system utilize the underground simple layer geothermal resources, including groundwater, soil and surface water, can heating and cooling. It's a kind of efficiency and energy conservation system. The operation principle: in the cooling season, the earth is regarded as a heat arrange place, draining the indoor heat and the compressor consumes energy to earth and then diffused the heat by the way of soil heat conduction and groundwater migration; In the heating season, the earth is regarded as the low temperature heat source, obtaining the heat through the burying pipe. The GSHP system is a energy renewable AC system, have the double benefit of energy conservation and environment protection. Therefore, the geothermal storage technology and high efficient heat pump have been classified as the most rising new technology in 21st century.

(3) Solar energy

The solar energy is used as the passive building heating. The hot water heated by the solar energy could be used as the heat source of heat pump or be directly used for radiate heating. In the building, the solar cell and the solar absorption refrigerate have the wide application prospect.^[7]

The solar energy technology that used in building include: solar energy air condition, solar energy heating, solar energy heat water, solar energy storage, GSHP, the solar energy generates electricity by the way of photovoltaic merging net, and so on. The building hot water supply can adopt the solar energy, utilize the solar energy collectors to obtain the hot water. Just like the cooling season, the heating season can also adopt the solar energy technology. The operation principle: as to solar energy building, it must build a thermal storage pool. In the heating season, the system supply the heat that come from the pool water heated by the solar to the building; While the heating season over, the system switch the pipeline that the hot which come from the solar energy collectors begin to drive the solar absorption refrigerate machine to store the cool to the pool; In the cooling season, the system supply the cool that come from the thermal storage pool to building, at the same time, the solar absorption refrigerate machine keep storing the cool to pool.^[8]

(4) The development of natural ventilation

The natural ventilation is a wide application resort for the building energy conservation. While using the natural ventilation to replace the AC refrigerate technology, there are two respects meanings. The first is achieving the passive refrigerate. The method can reduce indoor temperature and bring away the moist and dirty air by the way that do not consume the unrenewable energy. The second is supplying the fresh natural air, favorable to physiological and psychological health of human.^[9] The commonly used natural ventilation realize way include: 1 wind pressure 2 heat pressure 3 wind and heat pressure 4 machine

pressure 5 double layers envelope structure. Among them, the double layers envelope structure is the wide application technology that used in the ecological building, has been called as "Breathing Skin".^[10]

4.2.9 The transport system energy conservation

(1) Adopting the large temperature differential

While increasing the operation temperature differential of chilled water system and cooling water system, the system can reduce the water flow rate. Therefore, it can reduce the transport energy consumption and reduce the pipe diameter, save the initial cost.

(2) Increasing the supply air temperature differential

Just like the water system, while adopting the ice thermal storage technology, because of the low supply water temperature, the supply air temperature differential increase. Adopting the special induced outlet to direct air supply or utilize the terminal device for air mixture, the system can achieve the supply air temperature.

(3) The frequency conversion technology

The technology can raise the operation efficiency by the way that replace the governing value by the speed change pump and speed change fan.

5. THE DEVELOP TREND OF FUTURE ARCHITECTURE

According to the harmonious development among architecture, environment and energy, the develop trend of future architecture must be "Healthy Architecture", "Green Architecture", mainly reflect energy conservation and environment protection.

The definition to "healthy": the good state on the body, on the spirit, on the society. Therefore, the "Healthy Architecture" should be the building that make the occupant healthy. What the appearance of the concept of "Healthy Architecture" reflects the people's higher demand on the live environment. The AC system is the crucial part of "Healthy Architecture". Therefore, the future design of AC system should reflect the idea of "people first".

The "Green Architecture" refers to the architecture of effective utilization of resources, call "4R" building: Reduce the use of construction material, various kinds of resources and unrenewable energy; the use of Renewable energy and material; Recycle the material and water; Reuse the old material on the premise of construction safety.^[7] The "Green Architecture" emphasize the environment, energy conservation, the effective utilization of resources and material. The environment can divide into exterior and interior environment. The exterior ecological environment emphasize the environment protection and culture tradition protection. The interior environment emphasize the occupant comfort, health and IAQ. The energy conservation can be summed up the improvement of energy efficiency and the resources comprehensive utilization. The improvement of energy efficiency include the utilization of high efficiency

chiller, high efficiency boiler, high efficiency electrical machinery, the reduction of water system energy consumption, the utilization of make-up system. The resources comprehensive utilization include the exhaust heat recovery, the utilization of thermal storage system, the utilization of renewable energy, solar energy, geothermal, the sunlight. The future building will bring us the comfort environment and the high operation efficient and low operation cost system.

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