Shanghai Ecological Demonstration Building

Picture

Fig.1 Appearance of the building

Basic Information

Location:	Shanghai academy of building research, Shanghai
Climate:	South China, sea
Project brief:	The project is a key important demonstration building from the project “Key technology research and system integration of ecological building” carried out by shanghais science and technology committee. The project represents advanced technologies in the world, leading the national level from 5 to 10 years. The overall energy consumption is only 25% of traditional buildings, and renewable energy utilization rate is 60%.
Client:	Shanghai Academy of Building Research
Architect:	Design Institute of Shanghai Academy of Building Research
Timetable:	Start Project: November 2003 End date project: June 2004
Area:	1900 m^2
Cost:	4600 RMB / m^2

Design features

Bioclimatic features: "Stack effect" of natural ventilation; lighting effect of atrium skylight

Materials/ Construction: Brick and reinforced concrete for walls and roof

Technical features: Heat pump driven air conditioning, heat recovery technology, environmental friendly refrigerant: LiBr solution.
Multi-sun shading devices: controllable soft sun shading, adjustable horizontal or vertical sun shading with aluminum alloy window blind.
Hot water supply system: 4 m^2 flat solar collector on the top floor, 300 liter hot water is available.
Lighting system: 100 m^2 atrium skylight can save 1525 kWh electricity per year.
Renewable energy system: 5 m^2 PV modules, solar collector, solar lighting system, etc.
Sewage treatment system
Roof planting and atrium planting system

U-values: k=0.33 w/m^2k for walls
k=1.65 w/m^2k for glazing

Project Details

Context and site: Based on the climate, environment characteristics in Shanghai, economic development in Shanghai, and usable function after completion of the building, the demonstration building integrates various new ecological technologies and products, with ten technical characteristics in natural ventilation, low energy, natural lighting, healthy air conditioner, renewable energy, green building material, intelligent control, water resource utilization, ecological virescence, comfortable environment. The structure of the building is reinforced concrete, with two floors in south façade, three floors in north façade. East part with 350 m^2 of first floor is used to demonstrate the integration of used technologies. The building has become the pilot platform of researching key technologies and relevant products in ecological building.

Function & form: Low rise (three floors); office building, labs

Structural system: Steel frame and shearing force walls

Energy efficiency control:

Thermal insulation of building envelope: <u>Exterior façade:</u>

Number	Place	Insulation system	Heat transfer coefficient W/(m2K)	Thermal inertia D
1	East exterior façade	Concrete brick (90mm)+ froth urea (60mm) + grit +gas brick (240mm)	0.32	4.3
2	South exterior façade	EPS exterior insulation layer (140mm) +concrete brick (190mm)	0.27	3.2
3	West exterior façade	concrete brick (90mm)+ froth urea (85mm) +grit +gas brick (240mm)	0.29	4.3
4	North exterior facade	XPS exterior insulation layer (75mm) +concrete brick (190mm)	0.33	3.2

Window:

Number	Place	Type	Heat transfer coefficient W/(m2K)	Sun shading coefficient W/(m2K)	Permeation rate of visible light %
1	louver at sloping roof	PET low-E double layer glazing with middle hollow	1.82	0.62	68
2	Every exterior glazing	low-E double layer glazing with middle hollow	1.65	0.58	65

Sun shading devices:

Based on the architectural modality and sunlight rule, various sun shading technologies are selected to improve the heat insulation performance.

Based on energy efficiency and lighting requirements for louver, exterior part adopts controllable soft sun shading devices to decrease the energy consumption by air conditioning system.

South façade adopts adjustable horizontal sun shading devices with aluminum alloy window blind (Fig.2), to realize the different adjustment in summer and winter.

West façade adopts adjustable vertical sun shading devices with aluminum alloy window blind, according to the influence by western exposure in summer.

Fig.2 Adjustable horizontal sun shading devices with aluminum alloy window blind in south facade

Roof planting: The planting roof adopts inversed insulation system. It use XPS board and froth glass board to lay on top of water proof layer, which is corruption proof by plant root. Thus the multiplex roof is formed with heat preservation in winter and heat insulation in summer. The building roof owns totally nine locations with small planting gardens and one indoor atrium virescence (Fig.3). The total area for virescence is more than 400 m^2. The layers for planting includes insulation layer, water proof layer, water drainage, filtration layer, cultivation layer, and plant layer.

Fig.3 Planting roof with inversed insulation system

The planting roof offers the improvement of indoor air temperature, formation of biological buffer zone, purification of air, reduction of noise, extension of building life, adjustment of wind direction, etc.

Space heating cooling, ventilation, air conditioning:

The building adopts high efficiency, environment friendly air conditioning system (Fig.4) driven by heat pump, sensible and latent heat can be controlled separately. The mildew problem happen in common air conditioning system is avoid due to the lack of coil with condensed water. By salt solution spay in dehumidification machine, dust, bacteria and other deleterious matter can be eliminated.

The heat recovery technology in air conditioning system, 20% energy consumption can be decreased. Entire fresh air system improves the indoor air quality. By using environmental friendly refrigerant, i.e. LiBr solution, the demolishment by Freon refrigerant to ozonosphere is largely reduced.

Fig.4 High efficiency, environment friendly air conditioning system driven by heat pump

Lighting and illumination: 100 m^2 atrium skylight (Fig.5) improve the effective lighting area for east room up to 600 m^2, which can save 1525 kWh electricity per year, energy saving rate is 10.8%. In daytime, the indoor environment has fully natural lighting with 80% total area.

Fig.5 Lighting effect of atrium skylight

Renewable Energy use:

Solar collector (150 m^2) with vacuum tube and polycrystalline silicon PV panel (5 m^2) are installed on top of slope roof, realizing the integration of solar thermal and electricity.

The efficiency of the PV panel is higher than 14%, a 5 kW power station is connected with the public grid.

Solar collector serves Desiccant Evaporative Cooling (DEC) air conditioner and floor heating system as the heat resources, the system map can be found in Fig.6.

The DEC air conditioner serves exhibition hall in first floor in summer, and exhibition hall in first floor, wide open office in second floor (300 m^2) in winter with floor heating system. The heating design load is 25 kW.

4 m^2 flat solar collectors is installed on op of building, incorporated with assistant electrical heater, the system can offer 300 liter hot water.

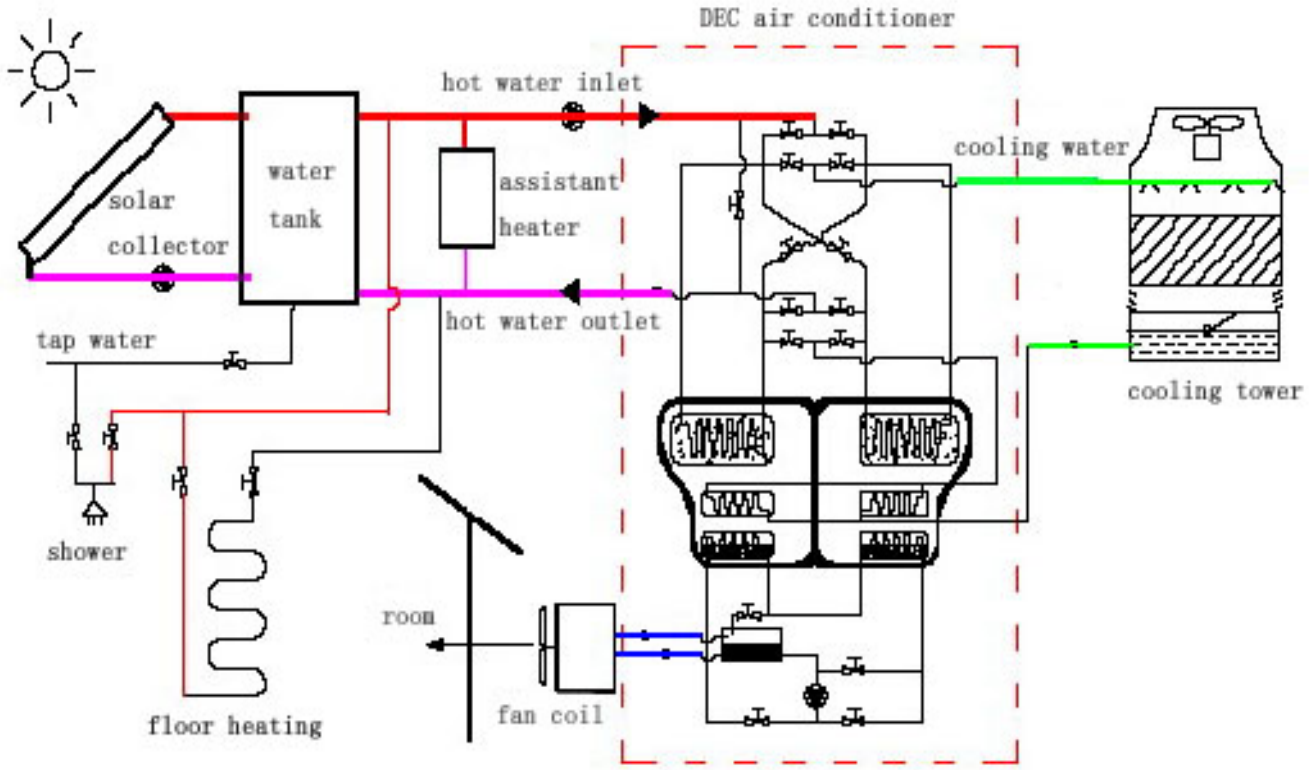

Fig.6 Integration system of DEC air conditioner and floor heating

Green site approach:

Sewage treatment

System: After biochemically treated, waste and rain water (20 m^3/day) becomes reclaimed water, which can be used for roof planting, landscaping, and road cleaning, etc. The treatment system adopts on live supervision system, every operational parameter is supervised. Based on inlet water quality, quantity and output data, other parameters can be automatically set, bringing the system more safe and reliable.