Design of Household Energy-saving Fresh Air Ventilation System

Yan Yang[1], Ran Lin[2]

1 Nanjing Vocational Institute of Industry TechnologyNanjing Jiangsu 210023, China
2 ChinaULAND Building Technology Co, LtdNanjing Jiangsu 210007, China
yangyanjs@126.com

Abstract. In this paper, through the example to illustrate the design idea and method of small residential projects household fresh air ventilation system based on improved performance and energy saving ways discussed total heat exchanger.

Keywords: Fresh air ventilation system; total heat exchanger; fresh air load.

1. Introduction

In recent years, urban air quality is deteriorated sharply, hot air purifier market reflects the desire of the targeted products. Air purifier can effectively improve indoor air quality, but it also has great limitations [1], it can not address indoor fresh air demand is the biggest drawbacks of air purifiers and similar products. Fresh air ventilation system provides a solution to the source of indoor air quality problems. For the new wind ventilators small residential projects usually plate-fin heat exchanger as a heat recovery system, the heat exchanger having a small size, easy installation, high efficiency heat exchanger [2].

2. The Design Fresh Air Ventilation System Used in the Domestic

2.1 Basic Information of Sample Project

The following are two fact sheet and size chart of basic items:

Table 1 Basic project fact sheet

	Project A	Project B
Project Location	Nanjing	Nanjing
Floor / total floors	8/27	5/11
Total floor area (m^2)	~120	~84

Project storey (m)	2.75	2.70
Each functional area(m^2)		
Master Bedroom	16	15
Second bedroom	12	11
Guest bedroom	10	-
Living Room	16	18
Aisle	6	-
Restaurants	12	14
Kitchen	5	4
Public health	4	4
Main Guardian	5	-
Balcony	*4*	*5*
Total area (m^2)	90	71
long-term residents	5	4
Per capital living space (F_p)	18	17.8

Fig. 1. Chart of project a apartment project size

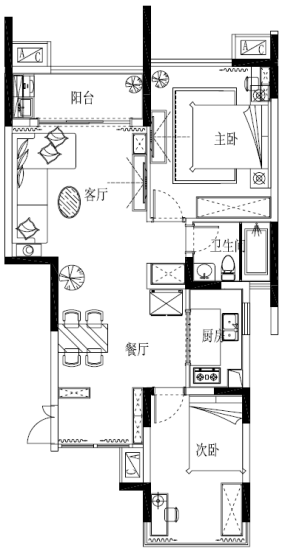

Fig. 2. Chart of project b apartment project size

2.2 Calculation of the new air system air volume

In this paper, new air systems are all in accordance with the whole house airtight, relying on fresh air ventilating system organizations indoor design conditions. Balcony sample project were done using living balcony, consider only natural ventilation, not as the research object fresh air system.

According to the Table 2 provisions of "civil heating, ventilation and air conditioning design specifications" (GB 50736-2012) on minimum ventilation rate of residential building, more than two projects Fp (per capita living space) between $10m^2$ and $20m^2$ between the minimum ventilation rate is 0.6 times, according to the area and calculate storey interior volume, considered the minimum fresh air is 141.9 m3/h and 106.9m3/h. Taking into account the above minimum air volume air volume according to the number of permanent staff calculations occur when you use (such as gathering, etc.) is much greater than the density of personnel count the number of personnel to be guaranteed and the left margin when the value in the selection of equipment.

The same ratio calculated in accordance with, 200 m3 / h air volume to meet the new demand of about 120m3 air ventilation area of the room type, which can be covered by a common two-room, three-bedroom house. Combined with wind, noise, static pressure and other technical indicators, as well as brand factors common type of insomnia on to inspect the final choice of a brand 250D and 150D models third gear speed wind ventilators as two new projects ventilation equipment, the largest air volume respectively 250cmh and 150cmh, wherein the third gear 250D model wind were 250cmh, 200cmh, 150cmh, 150D model third gear wind were 150cmh, 120cmh, 80cmh.

2.3 Design of equipment and piping systems

The new air system is mainly composed of new wind ventilators, air pipes and fittings, silencer plenum, air and other parts.

1. Selection of the position of the new wind turbine installation

System design should first solve the problem of a new arrangement of the fan. New fan arrangement requires to take the following factors into account and select the most suitable installation location:

(1) new fan may cause noise, so it should be arranged in places where there is less activity and with higher tolerance noise;

(2) new fans need to set aside a manhole in order to replace the filter;

(3) new fan has mounting height requirements, so it should be installed in less demanding on the story of the region;

(4) installation location should be easy to install a new air connection to the outdoors, the exhaust pipe;

(5) the installation location should be selected in a relatively centered position to balance the air supply pipe to the length of the points, and then balance the amount of wind.

Depending on the project, A project designed to select new fan installed in the kitchen, B project designed and installed in the bathroom.

2. Design of the air supply system

Considerations ventilation effect, the outlet of the sample project is set around the room, and center position is set on the relative focus back to the in the room.

There are two approaches of conventional air supply system. The first is to disperse by the competent air tree, leading to each branch line to the point of each blast. The second is to send main pipe to the plenum, air blast pipe each point are drawn from the static tank. The first approach are material savings, less resistance along the way, but for the convenience of installation, air duct usually choose U-PVC pipe or corrugated hose, specifications stereotypes, which makes it difficult to install and adjust the damper, so it is difficult to control the amount of air at various points . The second approach has greater resistance along the way, but the air is uniform. According to the project experience, we chose to use the second approach for example project, using U-PVC pipe as the air charge, fan outlet branch pipe of the same diameter. Sub-pipe use certain type Φ75 corrugated hose (inner diameter 61mm).

Table 2 The air supply system hydraulics table

	Project A	Project B
Maximum amount of wind (cmh)	250	150
Amount of outlet	6	4
Average amount of wind(cmh)	41.7	37.5
Manifold specification	Φ160	Φ110
Manifold length (m)	0.3	0.3
Explorer wind speed(m/s)	3.45	4.38
Longest branch pipe length (m)	15	8
Branch pipe wind speed (m/s)	3.99	3.61
Longest branch pipe pressure drop (Pa) note 1	75	33
Other pressure drop(Pa)note2	15	10
Total pressure drop (Pa)	90	43
Residual pressure (Pa)note3	100	90

3. Design of the return air, fresh air and exhaust system

Design of return air system often take centralized return air way ensure positive pressure indoors major functional areas. Centralized return air is usually set in the non-major functional areas. Toilet will produce a lot of water vapor in the shower, the presence of smoke pollution in the kitchen, so the return air should not be set in the above areas. For the sample project, return air of a project is set up in the bathroom

dry area, B project is set beside the bathroom door.

New outdoor air and the exhaust vents should be away from each other, and the new outlet should be arranged above the wind exhaust vents. Also outdoor fresh air should be away from the bathroom vent, kitchen hood exhaust port and other sources. New outlet and the exhaust ports of sample project are arranged on both sides of the external walls of the kitchen.

Because decentralized centralized return air blower airflow forms of organization and bedrooms area closed rooms and return air pressure differential exists. The sample project maximum ventilation ACH is converted into approximately 1 time per hour, taking into account the general situation seal doors and windows project, 1 time per hour ventilation can produce about 5Pa interior pressure, and the design comfortable air-conditioned of the room should be guaranteed when 5 -10Pa positive, so the sample project does not consider setting a pressure balance inside and outside the room device.

4. Design of outlet

The indoor outlet of project takes circular diffusers, return air with square diffuser, all ABS material, the neck size larger than the size of the duct to reduce wind speed, reduce wind noise and feeling. Outdoor air are dust cover installation of stainless steel and stainless steel mesh to avoid nesting birds and mosquitoes to enter.

The new air system each duct, outlet size and wind speed are as follows:

Table 3 Duct, outlet size and speed

Project		Duct diameter mm	Duct winds' speed m/s	Outlet size mm	Outlet speed m/s
Project A	air	Φ75	3.99	Φ110	1.23
	Return air note1	Φ160	2.76	250X250	1.39
	new wind	Φ160	3.45	Φ160	3.45
	Exhaust	Φ160	2.76	Φ160	2.76
Project B	air	Φ75	3.61	Φ110	1.10
	Return air note1	Φ110	3.51	200X200	1.04
	new wind	Φ110	4.38	Φ110	4.38
	Exhaust	Φ110	3.51	Φ110	3.51

5. Design

According to the above design features of new air ventilation system design, program plans are as follows:

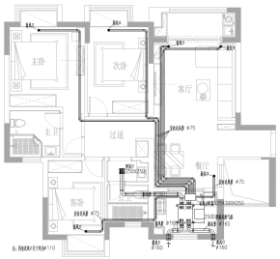

Fig. 3. A project fresh air ventilation system

Fig. 4. B project fresh air ventilation system

3. Impact of fresh air on the indoor air conditioning load

Because fresh air ventilator cannot process fresh air cooling and heating load. The introduction of new wind will increase the indoor heating load and the air conditioning load. The new wind ventilators built-in heat recovery unit can recover part of the whole energy, reducing indoor load. Below is the full heat recovery system works Fig.

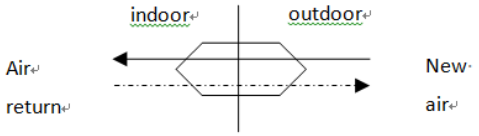

Fig. 5. Total Heat Exchanger Working Principle

In total heat recovery unit, outdoor air and indoor air return respectively get into a paper-like film separated space made of non-combustible mineral fibers. In the sensible and latent heat exchange surface of the film occurs, fresh air is sent into the room, return air discharged outdoor.

Total heat recovery will be as follows recovered energy and the need for additional cooling and heating load calculation to solve.

4. Conclusion

After design and calculation of the two small residential air system above, we can get the following conclusions:

1. The models with maximum amount of 200cmh wind new wind ventilators is able to meet the needs of most small-scale residential projects;
2. The amount of residual pressure margin of machine outside for small wind fresh air ventilator machine in the market;
3. The total heat exchanger can effectively recover exhaust energy and reduce air

conditioning load of fresh air;
4. Even with heat recovery, in extreme outdoor weather conditions new wind load is still too large.

These conclusions has important significance for improvements to the new wind ventilators specifications, performance and control methods.

References

1. National civil engineering design measures. HVAC Power (2009), China Planning Press,Vol. 12. (2009)
2. Civil heating, ventilation and air conditioning design specifications (GB 50736-2012), China Building Industry Press, Vol. 8. (2012)