SUMMARY

J.Bekker and J.van Hove, The ventilated façade. The paper reports about recent developments and about activities in the Netherlands in the near future, concerning the ventilated façade. The building of Billiton International Metals in The Hague (Netherlands) is an early development in the Netherlands. After a study and a laboratory research for this special building the start of a more general research to ventilated façades is reported. A literature research has been carried out, and an extensive measurement programme in combination with calculations in a computerized model, is announced. The research is a combined activity of the Bronswerk Airconditioning Research Centre and the Building Department of Eindhoven University of Technology.

RESUME

J.Bekker et J.van Hove, La façade ventilée. Le présent article revèle des développements récents et des activités dans la future prochaine, concernant la façade ventilée. Le bâtiment de Billiton International Metals à la Haye (Pays-Bas) est un des premiers exemples dans les Pays-Bas. Après un étude et une recherche dans le laboratoire, spécialement pour le présent bâtiment, le commencement d'une étude plus générale est rapporté. Une recherche de la litérature est executée, et un programme extensif de mesure, combiné avec des caculations dans une modèle d'ordinateur, est annoncé. L'étude est une activité commune du Centre de Recherche de Bronswerk et le Département du Bâtiment de l'Université Technologique d'Eindhoven.

KURZFASSUNG

J.Bekker und J.van Hove, Die Klimafassade. Der Vortrag berichtet über rezente Entwicklungen und über Aktivitäten in den Niederlanden in der nächste Zukunft mit Beziehung auf der Klimafassade. Das Gebäude von Billiton International Metals in Den Haag (Niederlande) ist eine Frühentwicklung in diesem Lande. Nach einer Studie und Laborarbeit speziell für das Billiton-gebäude, wird das Beginn einer mehr generell gerichtete Forschung auf Klimafassaden beschrieben. Eine Literaturforschung ist bereits ausgeführt. Ein ausführliches Messprogramm in Kombination mit Berechnungen mittels eines EDV-gesteuertes Modell, wird angekündigt. Die Forschungsarbeit ist eine gemeinsame Aktivität des Bronswerk Versuchslabors und der Bauabteilung der Technische Universität Eindhoven.

AIR FLOW WINDOWS IN HOT CLIMATES

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Introduction

Air flow windows, orginating in Scandinavia have been successfully used in northern climates for almost two decades. These windows have proven their worth in these cooler regions by providing maximum space comfort and energy savings to building owners and users throughout northern and central Europe and more recently in the northern states of the United States.

Little attention has been paid to the benefits of employing air flow windows in southern climates even though several buildings with air flow windows have been built and others are presently under construction in these climates.

This paper discusses the advantages of utilizing air flow windows in hot climates and the technical and functional aspects of engineering systems into the building design.

Even though, there exist several types of air flow windows, this paper refers only to that type of air flow window where return air from the room is forced through the window unit to the return air duct. This air flow window is also commonly known with such names as extract air window, air-curtain window and return-air window.

Space Thermal Comfort

Space thermal comfort is the basic requirement for efficient use of the perimeter zones of commercial buildings. The typical summertime problem which should be solved is caused by the sunlight, which streams directly through the window glazing and makes someone who is sitting just inside very uncomfortable. Therefore different tinted or reflecting glasses have been used to prevent this solar gain. This problem correlates also to the cooling demand and energy which is necessary to introduce into the space.

Because the air flow window allows room air between the panes this puts "cool" return air on both sides of the interior glass pane. This eliminates almost totally the difference in temperature accross the inner pane, therefore the inner pane is about at the same temperature as the room air.

In the figure 1 inner surface temperatures are given for typical windows in a hot summer day. It shows clearly the advantages of air flow windows specially when considering high solar intensity on the window surface.

Low surface temperature of the air flow window brings us two benefits:

- all the floor space next to the window can be efficiently used, no uncomfortable, unusable floor area is needed in front of the window
- reduced mean radiant temperature in the room improves the thermal comfort or allows to raise higher the set point of the thermostat from 1-2 degrees Celcius and still keep the same comfort level as with ordinary windows.

Cooling Energy Savings

When we discuss cooling energy consumption of the air flow window we have to consider two different situations. First, how the room feels the window and secondly, how the air conditioning system feels the window.

The window property, shading coefficient that is associated with combating direct sunlight is that factor which describes energy situation in the room next to the window. The air flow window has the lowest shading coefficient compared to any other type of window commonly used in commercial buildings today including any kind of tinted or reflecting glass (figure 2).

The air flow window system uses clear glass in achieving its shading coefficient. The way this is accomplished is that as the sun shines through the exterior sash of glass it warms up the metal venetian blinds, and then, before the blinds have a chance to reradiate that heat into the room, the air flow past the venetian blinds acts as a heat exchanger and takes the heat away from the window and transfers it into the air duct. This effect not only gives the window the remarkable shading coefficient, it also has now transformed every window into an active solar collector. The solar heat is now under total control in the return air duct, where it can be transported anywhere in the building.

How much the temperature of the return air forced through the air flow window will increase depends on the outside temperature and the solar intensity. In figure 3 return air temperatures, measured at the top of the air flow window, are given versus air flow rate and solar radiation.

The solar heat can be used for space heating, to preheat the domestic hot water or to heat the swimming pool or it can be used in any other desired fashion. In hot climates most time of the year there is no use for solar heat in the building, therefore solar heat should be exhausted in order to minimize the building's cooling load. Depending on the design situation in certain conditions it is more economical to return this heated air back to the HVAC system and cool it there mechanically, instead of exhausting it and taking hot and humid fresh air instead into the system.

Daylighting

The fact that the air flow window uses clear glass in accomplishing the solar collection and shading coefficient has another very beneficial effect. It allows most of the visible light through the window. The clear glass has high transmissivity and the venetian blinds, specially light coloured, rather than blocking the light, tend to act as light shelves to bounce the natural daylight deeper into the building.

In table 1 daylight transmittance factors are given for different windows. Also the number of daylight hours that can be utilized in sothern climates with air flow windows and most commonly used ordinary windows are shown in table 1 /4/. It shows clearly the advantages of clear class compared specially to heavily tinted windows which did not allow to utilize daylighting at all.

Daylight hours are based on the fact that when there is a level of 500 lx of illumination on the work plane all perimeter lighting will turn off.

Table 1. Daylight transmittance factors and daylight hours for different windows

Window	Daylight trans-mittance	Daylight hours lattitude 20°	30°	40°
Bronze ting, single pane	0,52	1431	1298	1032
Bronze tint, double pane	0,47	1414	1281	1025
Silver tint, single pane	0,19	-	-	-
Silver tint, double pane	0,17	-	-	-
Air flow, 1 + 1 panes	0,71	1514	1414	1131
Air flow, 2 + 1 panes	0,65	1464	1381	1105

HVAC System and Airflow Windows

The air flow window system is an integral part of the buildings HVAC system. Therefore, in order to utilize the assets of air flow windows efficiently, there are some basic rules that should be taken into consideration.

Duct Connection

Each window should be connected to the return air duct system. The pressurization in the return air system should be engineered so that the design air flow is forced through every single air flow window.

Return Air

Separate return air ducting is needed for south and west windows because these generate most of the solar heat and during most time of the year this solar warmed air is economical to be expelled.

Air flows

Typical air flow rate is between 8 dm^3/s...25 dm^3/s per square meter of window area. Final air flow rate should be determined taking internal and external loads into consideration. Both variable and constant air volume air conditioning systems have been successfully used with air flow windows.

Controls

A sophisticated control system is required to optimize systems operation. Basic functions needed to achieve optimum performance are

- when to use return air from south and west windows
- when to use return air from north and east windows
- when to use exhaust air from south and west windows
- use of economizer cycle.

Conclusions

Air flow window system

- brings comfortable thermal indoor conditions in both arid and tropical weather conditions
- allows to use efficiently interior floor space next to the window
- saves cooling energy and decreases cooling demand
- acts as an active solar collector
- allows to maximize the daylight utilization.

Two pane air flow window (single exterior pane and single interior one) may be used in hot climates. Double pane exterior sash is needed only if winter dimensioning temperature is bellow zero degree Celcius.

Good engineering work is needed in oder to utilize all the air flow window systems advantages.

References

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(3) Lawrence Berkeley Laboratory 1981. "Evaluation of Air Flow Windows, Final Report", University of California, Berkeley, California.

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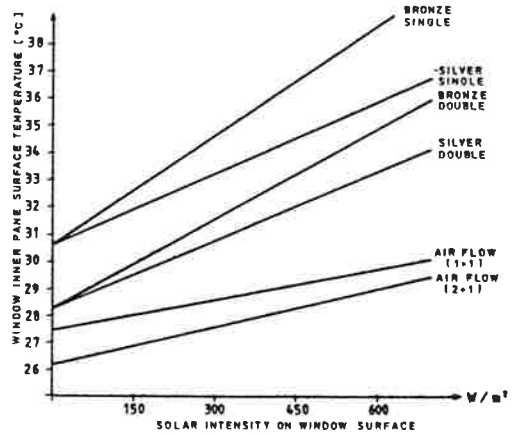
Figure 1: Inside surface temperatures of different windows



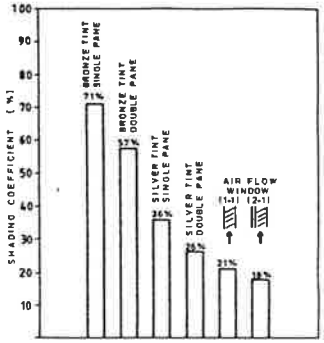


Figure 2: Typical shading coefficients

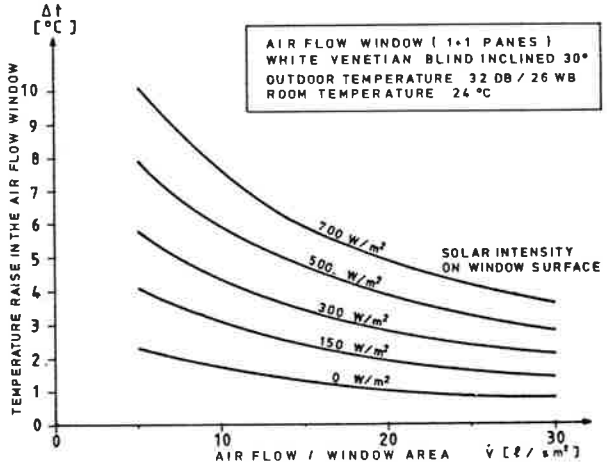


Figure 3: Temperature raise in a air flow window versus air flow rate and solar radiation.

SUMMARY

H. RIPATTI: Air Flow Windows in Hot Climates. This paper discusses the advantages of utilizing air flow windows in hot climates and the technical and functional aspects of engineering air flow window systems into the buildings. Air flow windows offer several advantages to building owners such as maximum space comfort, more usable floor space, energy and monetary savings and possibilities to utilize daylighting in the optimal way. Additionally air flow windows seem to be easily combined with all commonly used air conditioning systems. Even though comparisons have been made between air flow windows and typical windows used in hot climates, it looks evident that they are not comparable products, specially because air flow window system is a unique product with multipurpose functions operating actively as the first element of buildings air conditioning system.

RESUME

H. RIPATTI: Les fenêtres ventilées en climat chaud. Ce rapport présente les avantages apportés par l'utilisation de fenêtres ventilées en climat chaud et les aspects techniques et fonctionnels de conception de ces systèmes pour les bâtiments. Ce type de fenêtres permet aux propriétaires de réaliser des économies d'énergie et financières, d'offrir un confort et une surface de sol utisable accrus et d'utiliser au mieux la lumière du jour. Les fenêtres ventilées sont aisément intégrables aux systèmes de ventilation courants. Bien qu'ayant été comparée avec les fenêtres conventionnelles et typiques de climats chauds, la fenêtre ventilée est un produit à part à cause de la polyvalence de ses fonctions et par le fait qu'elle est la cellule de base active du système d'air conditionnè.

KURZFASSUNG

H. RIPATTI: Abluftfenster in heissen Klimaten. In diesem Vortrag behandelt man die Vorteile der Abluftfenster in heissen Klimaten. Auch technische Funktionsprinzipien für die Planung des Abluftfenstersystems werden betrachtet. Abluftfenster bieten den Gebrauchern viele Vorteile: maximale thermische Raumkomfort, mehr Nutzfläche, Senkung des Energieverbrauchs, Reduzierung der Kosten und Möglichkeit Tageslicht optimal zu nutzen. Abluftfenster sind leicht in alle gewöhnliche Lüftungsanlagen beizufügen. Obwohl man in heissen Klimagebieten Abluftfenster mit konventionellen Fenstertypen verglichen hat, ist es klar, dass sie keine vergleichbare Produkte sind. Das Abluftfenster ist ein einzigartiges Produkt, das aktiv und vielseitig als Teil des Lüftungssystems im Gebäude funktioniert.