

A BUILDING ELEMENT HAVING AN IMPROVED CAPABILITY OF ABSORBING RADIATION AND AN IMPROVED METHOD OF COOLING A WHOLE HOUSE ENVIRONMENT

FIELD OF THE INVENTION

The present invention relates to a building element having an improved capability of absorbing radiation and an improved method of cooling a whole house environment by improving natural ventilation within the whole house environment.

BACKGROUND

In tropical countries, such as Singapore and Malaysia, it is essential to use architecture, especially to achieve sustainable environment, to improve the thermal performance of the buildings corresponding to local climatic conditions so as to create comfortable indoor climate without much dependence on energy-consuming technologies. It will also be an urgent agenda for developing countries, which are expected to rapidly increase their energy resource consumption due to rapid industrial development.

As a matter of background, heat enters and leaves a building through the roof, walls, windows and floor. Internal walls, doors and individual room arrangements affect heat distribution within a house. These building elements, that is, the roof, walls, windows and floor, are collectively referred to as the building envelope. Envelope design is the integrated design of building form and materials as a total system to achieve optimum comfort and energy savings. It should be noted that good envelope design responds to climate and site conditions to optimize the thermal performance. It can lower operating costs, improve comfort and lifestyle and minimize environmental damage.

A comfortable indoor environment for human to inhabit should preferably have an ambient temperature in a range of 21°C to 24°C, although an ambient temperature in the range of 20°C to 26°C would also be acceptable. Humidity of the air should preferably be in the range of 40% to 60%. Studies have shown that fresh air rates should preferably be 10 liters per second (L/s) per person or 10 L/s per 10m² for mechanical ventilation system. The optimum air movement within the house should preferably be 0.1 m/s to 0.5 m/s (for a naturally ventilated environment) and 0.1 m/s to 0.2 m/s (for an air-conditioned environment). The movement of air within the house is also critical as it would prevent air

stagnation. The air quality, which is being measured by the ratio of negative ions and positive ions, is also another critical factor for a comfortable indoor environment.

Indoor air pollutants should also be kept to a minimum for an indoor environment to be comfortable to a human body. This is because exposure to indoor air pollutants can pose a significant health risk. Exposure to indoor pollutants has been linked to a range of health problems, such as headache, fatigue, coughing, flu symptoms, dizziness and eye, nose, throat and skin irritation. Fresh air exchange is the cornerstone of good indoor air quality and air is such a critical element to the well being of people in their daily life, since an average person consumes approximately 1 kg of food, 2 kg of water and 20 kg of air daily.

A study has shown that in Malaysia, a comfortable indoor ambient temperature should be in the range of 25.5°C to 28°C. Humidity of the air should preferably be in the range of 40% to 60% and the optimum air movement should preferably be 0.3 m/s to 0.5 m/s (for a naturally ventilated environment). Notwithstanding, it should be noted that a variation in perceived comfort varies with different age groups, different races, different cultures and different countries.

To attain a comfortable indoor climate, it should be noted that there are architectural and mechanical methods. The former is known as "passive design", which is an architectural designing technique that focuses on local climatic conditions to utilize natural energy such as sunlight, temperature fluctuation, natural winds and ground temperature. The latter method relies on heating and/or cooling systems and air-conditioners. In tropical countries, as dependence on cooling systems or air-conditioners increases, growing concern over the future global environmental problems and a possible drain on energy resources necessitate the importance of development of the passive design, especially in passive cooling technology. Other advantages of passive design, as compared with using mechanical methods for cooling indoor environment, are that greenhouse gas emissions are reduced and electrical bills are also reduced leading to reduced utilization of non-renewable natural resources.

One such existing passive cooling technology relies on the combination of 'supply air' windows with Passive Stack Vents in household dwellings. A 'supply air' window has a vent (also known as passive stack vent) at the outer frame and inner frame of the windows. Due to the pressure drop induced by a mechanical air suction within the passive stack vent, air is extracted from the kitchen and bathroom (where the 'supply' air windows

are installed). The 'supply air' windows can be double or triple-glazed but rely on a smooth flow of air through the window, which very effectively captures heat escaping from the room and delivers it to the space in the passive stack vents at the top of the inner frame, as pre-warmed ventilation. Having largely eliminated conductive heat loss, the other major heat loss mechanism is radiation across the window pane from inside to outside, and that is countered by placing a hard low-Emittance (low-E) coating (an ultrathin transparent metallic coating that improves thermal insulation) on the surface of the inner pane facing into the flow of air. To summarize, the internal room temperature is lowered by the dissipation of the heat by the passive stack vents and also the absorption of radiation by the low-Emittance coating of the window panes.

The ventilation system utilizing the passive cooling technology reduces household heating requirements, fossil fuel and primary energy consumption, and thereby CO² emissions. Tests carried out have demonstrated that a 'supply air' window incorporating just 2 panes of glass and one low-E coating can achieve a U-value of 0.8 W/m²K compared with 2.0 W/m²K when using the same design in a non-ventilated, conventional mode, that is, without the passive stack vents.

Other objects and advantages of the present invention will become apparent from the following description, taken in connection with the accompanying drawings, wherein, by way of illustration and example, an embodiment of the present invention is disclosed.

SUMMARY OF THE INVENTION

In accordance with a first aspect of the present invention, there is provided a brick element, for absorbing radiation, comprising of a cavity extending therethrough, whereby the cavity has a cross sectional area, the cross sectional area have a first portion at one end and a second portion at the other end, in which the first portion is smaller than the second portion, wherein the first portion and the second portion are integral.

In accordance with a second aspect of the present invention, there is provided a method of cooling an inner house environment of a house, the house having a wall, the method comprises of constructing the wall with at least one brick element, whereby the first portion of the brick element faces a source of radiation.

BRIEF DESCRIPTION OF THE DRAWINGS

Further objects of this invention, together with additional features contributing thereto and advantages accruing therefrom, will be apparent from the following description of an embodiment of the present invention which is shown in the accompanying drawings with like reference numerals indicating corresponding parts throughout and which is to be read in conjunction with the following drawings, wherein:

Figure 1 is the perspective view of the brick element according to an example embodiment of the present invention;

Figures 2 and 3 are the perspective view of the brick element according to other embodiments of the present invention;

Figure 4 shows the arrangements of the brick elements according to an example embodiment of the present invention;

Figure 5 shows the arrangements of the brick elements according to another example embodiment of the present invention;

Figure 6 is the cross sectional view of a typical house having part of the wall being constructed with the brick elements;

These and additional embodiments of the invention may now be better understood by turning to the following detailed description wherein an illustrated embodiment is described.

DETAILED DESCRIPTION

Throughout this description, the embodiments and examples shown should be considered as exemplars, rather than limitations on the apparatus and methods of the present invention.

A building element, shown as a brick 1 in an example embodiment, as shown in Figure 1, comprises a cavity 2 extending therethrough. It will be appreciated that there may be more than one cavity in different embodiments.

The brick 1 has a substantially rectangular cross sectional shape and a cavity having a cross sectional area, the cross sectional area have a first portion at one end and a second portion at the other end, in which the first portion is smaller than the second portion. In the figure, the first portion and the second portion are integral. However, it is envisioned that the 1st portion and the second portion are distinct, but in close relation to each other. In the embodiment of Figure 1, the cavity has a substantially triangular shape 2a at one end and a substantially cross sectional rectangular shape 2b at the other end, each of the two cross sectional shapes having an arbitrary depth, as shown in Figure 1. It would be appreciated that the cross sectional shape of the brick 1 and the cavity 2 are not restricted to the ones as shown in Figure 1.

In another example embodiment of the present invention as shown in Figure 2, the brick 1 comprises a cavity 2 extending therethrough. The brick 1 has a substantially rectangular cross sectional shape 1a. As shown, the cavity 2 has a substantially triangular cross sectional shape 2c at one end or 1st portion and another substantially triangular cross sectional shape 2d at the other end or 2nd portion of the cavity.

In a further example embodiment of the present invention as shown in Figure 3, the brick 1 may have a substantially triangular cross sectional shape 1b with a substantially hexagonal cross sectional shape 1c extending from an apex of the triangular shape 1b. The brick 1 comprises a cavity 2 extending therethrough. As shown, the cavity 2 may have a substantially triangular cross sectional shape 2e at both ends, i.e. at the 1st and 2nd portion of the cavity.

In an example embodiment as shown in Figure 4, when in use, the brick 1 (similar to the one shown in Figure 1) is disposed in a position where one of the apexes of the triangular shape 2a of the cavity 2 faces the source of radiation 10, for example the sun. The bricks 1 may be arranged side by side as shown in arrangement 3a. In arrangement 3b, a buffer brick 4 may be disposed in between the bricks 1 (similar to the one shown in Figure 3). As shown, the buffer brick 4 may have substantially triangular cross sectional shape 4a without a cavity therethrough. It would be appreciated that the arrangement of the bricks is not restricted as the ones as shown in arrangements 3a and 3b, just as long as the arrangement is such that the brick is arranged so that the 1st portion is directed towards the source of radiation, and the 2nd portion is directed away from the source of radiation.

As shown in Figure 4, multiple arrangements 3a, 3b may be stacked one over another to form the wall of the house (as shown in Figure 6). As a corollary, the cavities 2 of the bricks 1 form a vertical air column 6c as shown in figure 6. It should be noted that due to the apex of the triangular shape 2a, 2e of the bricks 1 faces the source of radiation 10, for example the sun, the triangular shape 2a, 2e of the bricks 1 minimizes the surface area to volume ratio. Further, it also reduces the relative area of highly conductive envelope elements by minimizing the surface area to unit relationship. As a corollary, the rate of heat transmission through the bricks is reduced. The thermal transmission equation is given as $k = Q \cdot t / A \cdot \Delta T$, in which the thermal conductivity (k) is defined as the time rate of heat flow, under steady conditions, through unit area, per unit temperature gradient in the direction perpendicular to the area, Q = watts, t = thickness, A = area, and $\Delta T = (T_a - T_d)$ is the temperature gradient required to conduct the heat.

When there is a temperature difference between the inner side and the outside of the wall of the house, heat will flow through the wall in order to achieve thermal equilibrium on both sides of the wall. As long as the inner side and outer side of the wall are maintained at two different and constant temperatures, the rate of heat flow through the wall will remain constant. This is also known as the steady state condition, which will be described more in Figure 6.

In another example embodiment of the present invention as shown in Figure 5, the brick 1 (similar to the one shown in Figure 2) is disposed in a position where one of the apexes of the triangular shape 2c of the cavity 2 faces the source of radiation 10, for example the sun. The bricks 1 may be arranged side by side as shown in arrangement 3c. In arrangement 3d, a buffer brick 4 without a cavity therethrough, may be disposed in

between the bricks 1 (similar to the one shown in Figure 3). As shown, the buffer brick 4 may have substantially triangular cross sectional shape 4a.

As shown in Figure 5, multiple arrangements 3c, 3d may be stacked over one another to form the wall of the house (as shown in figure 6). As a corollary, the cavities 2 of the bricks 1 formed a vertical air column 6c as shown in figure 6. It should be noted that due to the apex of the triangular shape 2c, 2d of the bricks 1 facing the source of the radiation 10, for example the sun, the triangular shape 2c, 2d of the bricks 1 minimize the surface area to volume ratio. Further, it also reduces the relative area of highly conductive envelope elements by minimizing the surface area to unit relationship. As a corollary, the rate of heat transmission through the bricks is reduced. When there is a temperature difference between the inner side and the outer side of the wall of the house, heat will flow through the wall in order to achieve thermal equilibrium on both sides of the wall. As long as the inner side and outer side of the wall are maintained at two different and constant temperatures, the rate of heat flow through the wall will remain constant. This is also known as the steady state condition, which will be described more in Figure 6.

Figure 6 illustrates a method of cooling a typical whole house environment by constructing the wall 6 of the house 5 with the bricks 1. As shown, the house 5 comprises of a wall 6 in the example embodiment. The wall 6 may further comprise of an inner pillar 6a and an outer pillar 6b each formed with any of the arrangements 3a, 3b, 3c, or 3d. The inner pillar 6a and the outer pillar 6b are arranged space apart, and having an air column 6c therebetween. As described earlier in figures 5 and 6, when multiple arrangements 3a, 3b are stacked over one another to form the wall, the cavities 2 of the bricks 1 in arrangement form another the air column 6c.

An orifice 7 may be introduced at a position 8a, at a top segment, through the inner pillar 6a and outer pillar 6b and another orifice 7 being introduced at a position 8b at a bottom segment, through the inner pillar 6a and outer pillar 6b. There is also provided an orifice 7 introduced at a higher position 8c in the inner pillar 6a and another orifice 7 being introduced at a lower position 8d in the inner pillar 6a.

The air column 6c may draw the cooler air from within the house 5a via the orifice 7 at positions 8c, 8d in order to achieve a constant temperature, which is lower than the temperature at the outer side of the bricks. Thus, the air column 6c acts as an air curtain

to supply constant colder air from within the house 5a in order to maintain the steady state condition.

When in the arrangement and when a source of radiation is present, the air within the house 5a near the wall 6 experiences a rise in temperature due to the heat being radiated through the wall 6, albeit a reduced amount of heat due to the bricks 1 as previously explained. It is general knowledge that the movement of air is due to differences in pressure and density of air of differing temperatures. Thus, the air within the house 5a near the air column 6c becomes less dense and the air rises and exits out of the orifice 7 at position 8a. A colder mass of air enters the house via the orifice 7 at position 8e which is shaded and not facing the source of radiation. The cold air thereby displaces the warmer air which rises upward. In other words, the warmer air is being driven by thermal force or thermal buoyancy upwards and out of the house 5 via the orifice 7 at position 8a. Such a phenomenon is also known as the chimney effect or stack effect. Thus, the chimney effect or stack effect enables the ventilation of air within the house 5 i.e. from one end of the house to another. Such ventilation is also known as cross ventilation or natural ventilation.

It will be appreciated that there may exist other types of construction of the wall of the house with the bricks 1 in other embodiments, for example, the wall of the house being constructed entirely with the bricks 1 (not shown).

In the example embodiment, the bricks and the orifices may be oriented for maximum exposure to cooling breezes. Barriers to airflow paths may be reduced to increase natural ventilation. Fans may be provided to improve ventilation and air movement in the absence of breeze. Floor plan zoning may be provided to maximize comfort for daytime activities and sleeping comfort. Appropriate windows and glazing may also be provided to minimize unwanted heat gains and maximize ventilation. There may be an adequate level of appropriate insulation. Effective shading may also be provided. There may also be use of light colored roofs and walls to reflect more solar radiation and thus reduce heat gain.

In other examples of the embodiment, unobstructed cross ventilation paths may be designed. Hot air ventilation may be provided at a ceiling level for all rooms with spinnaways, shaded opening clerestorey windows or ridge vents. Outdoor areas around the house may be shaded with planting and structures may also be shaded to lower ground temperature. Insulation solutions, such as advanced reflective insulation systems

and reflective air spaces, may be used to minimize heat gain during the day and maximize heat loss at night. Windows with maximum opening areas (louvers or casement) may be used and fixed glass panels are preferably avoided. Ceiling fans may be included to create air movement during still periods. "Whole of house" fans with smart switching may be used to draw cooler outside air into the house at night when there is no breeze. Planting design may be used to funnel cooling breezes and filter strong winds.

It has been found by the present inventor that the above provided an improved method of cooling the whole house environment and capable of reducing indoor air pollution. In particular, bricks having an improved capability of absorbing radiation, are constructed as part of the structure of the house or building. The bricks absorb the radiation from the sun and keep the internal whole house environment ventilated with fresh and cooler air. Since the bricks are formed as part of the structure of the house or building, the house or building is ventilated with fresh and cooler air round the clock and there is no necessity of paying any energy bills. Compared with the existing passive cooling technology, negligible maintenance is required. Further, lesser fossil fuel is consumed and thus there is lesser pollution.

Although exemplary embodiments of the present invention have been shown and described, it will be apparent to those skilled in the art that a number of changes, modifications, or alternations to the invention as described herein may be made, none of which depart from the spirit of the present invention. All such changes, modifications and alterations should therefore be seen as within the scope of the present invention.

CLAIMS:

1. A brick element, for absorbing radiation, comprising of a cavity extending therethrough, whereby the cavity has a cross sectional area, the cross sectional area have a first portion at one end and a second portion at the other end, in which the first portion is smaller than the second portion.
2. A brick element according to claim 1, wherein the first portion and the second portion are integral.
3. The brick element according to any one of claims 1 or 2, wherein the cavity has a substantially rectangular cross sectional shape at one end and a substantially triangular cross sectional shape at the other end, each of the two cross sectional shapes having an arbitrary thickness.
4. The brick element according to any one of the preceding claims, wherein the brick element is made of high-density material.
5. The brick element according to any one of the preceding claims, wherein the brick element has a substantially rectangular cross-sectional shape.
6. A method of cooling an inner house environment of a house, the house having a wall, the method comprises of constructing the wall with at least one brick element according to claim 1, whereby the first portion of the brick element faces a source of radiation.
7. The method according to claim 6, wherein the wall comprises of an inner pillar and an outer pillar spaced apart and having an air column therebetween.
8. The method according to claims 6 or 7, wherein a first orifice being introduced at a position above the inner pillar and outer pillar and a second orifice being introduced at a position below the inner pillar and outer pillar, a third orifice being introduced at a higher position in the inner pillar and a fourth orifice being introduced at a lower position in the inner pillar.

9. The method according to any one of claims 6 to 8, wherein at least one brick is constructed at a higher position in the outer pillar and at a lower position in the outer pillar.