A window insulator is provided. The window insulator may comprise a plurality of layers, with each layer performing a desired function. A thermal insulation layer may be provided. A reflective layer may be provided and coupled to the thermal insulation layer. The window insulator may also include a surface coupling layer. The surface coupling layer may be coupled to at least one of the reflective layer or the thermal insulation layer.
FIG. 3
(Prior Art)
FIG. 4
(Prior Art)
Annual Savings for Insulated Panel Use.
(Boulder CO, 5730 HHD/yr, Oil heat $2.67/gal)

FIG. 10

Annual Savings for Insulated Panel Use.

FIG. 11
REMOVABLE WINDOW INSULATOR

RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. provisional application No. 61/063,202 filed on Feb. 4, 2008 entitled "Removable Window Insulator Panel" and U.S. provisional application No. 61/126,967 filed on May 9, 2008 entitled "Adhesive-less attachment device for a removable window insulator panel" which are both hereby incorporated by reference into this application.

TECHNICAL FIELD

[0002] The present invention relates to an insulator panel, and more particularly, to a removable window insulator panel.

BACKGROUND OF THE INVENTION

[0003] With the increasing cost associated with energy as well as the increased environmental concerns associated with fuel, there is an increasing demand to develop solutions that can decrease energy demands. Within buildings, one of the greatest losses of energy occurs through windows. The heat lost and gained through a building’s windows can typically approach 30% of the total building’s heat lost or gained due to the window’s high thermal conductivity and poor ability to reflect the sun’s radiant heat. During the summer, east, west, and southerly facing windows can provide substantial solar heat gain during the day. The solar gain heats the inside of the building to the point where it is uncomfortable and often requires the use of energy for cooling. Conversely, during the colder periods, a window’s high thermal conductivity allows heat within the building to easily escape, thereby requiring increased energy to retain the inside temperature at a comfortable level.

[0004] During the winter months, the outside temperature, $T_{\text{out}}$, is typically colder than the desired comfortable temperature inside the building, i.e., $T_{\text{inside}} > T_{\text{out}}$. In order to maintain the comfortable temperature inside the building some sort of heating device is used which raises the temperature in the interior of the building to $T_{\text{inside}}$ and maintains it at this level by replacing the heat lost through the windows or similar openings. The heat loss is governed by the laws of physics and thermodynamics that dictate that the heat flows from higher temperature, $T_{\text{inside}}$ to lower temperature, $T_{\text{out}}$. If this lost heat is not replaced, the temperature inside will start to fall and will eventually become equal to the colder temperature, $T_{\text{out}}$. Thus in order to maintain a comfortable temperature, $T_{\text{inside}} > T_{\text{out}}$, the continuous use of a heating device is necessary (see FIG. 1).

[0005] FIG. 1 shows a cross-sectional view of a window 104 installed in a building. The window 104 separates the outside 101 from the interior 100 of the building. The window 104 is held in place by a window frame 103 that is installed in a wall 102 as is known in the art. A furnace or other heating device 105 attempts to maintain the interior temperature of the building at a desired interior temperature $T_{\text{inside}}$.

[0006] For a given size window 103, the amount of heat loss per unit area of the window generally depends on two parameters; a U-factor and the difference between the inside and outside temperatures, $T_{\text{inside}} - T_{\text{out}}$. Generally, heat loss can be characterized as:

$$\dot{q} = k(T_{\text{inside}} - T_{\text{out}})$$  \hspace{1cm} (1)

where:

- $\dot{q}$ is the heat loss per unit time; and
- $k$ is the thermal conductance.

[0010] The temperature difference $(T_{\text{inside}} - T_{\text{out}})$ is the driving force behind the heat loss (transfer). If $k=0$, then the material is called a perfect insulator and $\dot{q}=0$. However, the conductance, $k$, can be very small but not equal to zero. As equation (1) shows, for a given temperature difference, the smaller $k$ is, the smaller the heat loss. To understand the function of an insulator, consider FIG. 2.

[0011] In FIG. 2, $L$ represents the thickness of the insulator 200 and $A$ represents the area covered by the insulator (for example it can be the area of a window). The temperature $T_1$ is the warmer side and $k$ is the conductance of the insulating material.

[0012] For this case equation (1) is rewritten as,

$$k = -\frac{\dot{q}}{(T_1 - T_2)}$$  \hspace{1cm} (2)

[0013] From equation (2) it is seen that as long as there is a temperature difference, when $k=0$, $\dot{q}=0$. Furthermore when $k$ is small, $\dot{q}$ is also small. Equation (2) can also be expressed as:

$$\kappa = \frac{\dot{q}}{(T_1 - T_2)A/L}$$  \hspace{1cm} (3)

[0014] The constant, $\kappa$ is called the thermal conductivity and $1/\kappa$ is called the thermal resistivity, and is defined as:

$$\frac{1}{\kappa} = \frac{(T_2 - T_1)A}{\dot{q}L}$$  \hspace{1cm} (4)

[0015] The quantity $\kappa/L$ is called the U-factor of the insulator, the inverse of which is called the R-value. The R-value is a measure of a building material’s thermal resistance typically used in industry. Insulators with a small U-factor (high R-value) reduce the heat transfer. As the definition of the U-factor suggests that in order to have a small U-factor, the insulator must have greater thickness, L, or smaller conductance (poor conductor of heat). $k$ or both. Equation (4) suggests that the smaller the U-factor (larger R-value) the smaller the heat flow across A. Thus, use of insulators having a high R-value reduces the heat transfer resulting in less heat lost to the outside when the interior of the building is heated and less heat gained from outside when the same is cooled.

[0016] Most contemporary buildings in the United States have double pane, or so-called insulated windows and often these windows are tinted to control the amount of radiant heat transmitted through the window. Two pane tinted windows have the so-called R-value of approximately 2. This low R-value causes substantial heat transfer across the window panes. If somehow the heat transfer across the windows can be mitigated, the net result would be a substantial reduction in energy usage either when the building is cooled during the summer months or when the building is heated during the winter months. It should be appreciated that “window” is used for all possible openings including doors, such as the patio glass doors and the like.
When an insulator is not present, as it is shown in FIG. 1, the heat loss, $q_{out}$, to the outside in the winter months will be greater compared to the case when the insulator is present as it is shown in FIG. 3. Addition of a prior art window insulator 300 to a window 104 reduces the U-factor of the opening thus reducing the heat transfer (loss) to the outside in winter months. Thus, when the window insulator 300 is present, more heat is retained in the interior. The burning time of the furnace will be less. Hence the use of a window insulator results in cost savings and less greenhouse gases will be released into the atmosphere.

In the summer months, when $T_{out}$ is greater than $T_{inside}$, the heat transfer takes place from outside into the interior of the living space. The influx of heat raises the temperature of the living space. The heat flow continues until $T_{out} = T_{inside}$. To cool the interior of the building, heat should be removed from the interior. This is customarily accomplished by an air-conditioning unit 106. See FIG. 4. The prior art window insulator 300 in summer months reduces the heat entering from the outside to inside due to conduction. However, the prior art window insulator 300 fails to prevent heat gain due to thermal radiation. Radiative heat transfer is more prevalent during the summer when the temperature outside, $T_{out}$, is greater than the temperature inside, $T_{inside}$. Prior art window insulators do not address this problem. Therefore, the temperature inside the building can still be significantly increased due to radiative heat gain from the sun even when a prior art insulator is in place. The present invention reduces the radiative heat transfer using a novel window insulator.

SUMMARY OF THE INVENTION

A window insulator is provided according to an embodiment of the invention. The window insulator comprises a plurality of layers coupled together. The window insulator may comprise a thermal insulation layer for reducing a thermal conductivity through the panel. A reflective layer can be provided to reflect thermal radiation entering through the window. The reflective layer can be coupled to the insulation layer. A surface coupling layer may be provided for coupling the window insulator to the window or other nearby surface.

A method for insulating an opening is provided that utilizes a window insulator according to an embodiment of the invention. The method comprises reducing a thermal conductivity through the opening using a first layer of the window insulator. The method also comprises reducing a thermal radiation through the opening using a second layer of the window insulator. The second layer of material can be coupled to the first layer of the window insulator. The first and second layers can then be coupled to the opening.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a cross sectional view of a window without an insulator.

FIG. 2 the general principles of an insulator.

FIG. 3 shows the general heat transfer through a window with a window insulator in place when the inside temperature is greater than the outside temperature.

FIG. 4 shows the heat transfer through a window with the window insulator when the outside temperature is greater than the inside temperature.

FIG. 5 shows a cross-sectional view of a window insulator according to an embodiment of the invention.

FIG. 6 shows a cross-sectional view of the window insulator coupled to a window according to an embodiment of the invention.

FIG. 7 shows the window insulator according to another embodiment of the invention.

FIG. 8 shows the window insulator according to yet another embodiment of the invention.

FIG. 9A shows an attachment device for coupling the window insulator to a window according to an embodiment of the invention.

FIG. 9B shows the attachment device coupled to the window insulator according to an embodiment of the invention.

FIG. 9C shows the window insulator coupled to a window according to an embodiment of the invention.

FIG. 9D shows the window insulator including a plurality of attachment devices according to an embodiment of the invention.

FIG. 10 shows a graph depicting an amount of money saved using the window insulator according to an embodiment of the invention.

FIG. 11 shows another graph depicting an amount of money saved using the window insulator according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

FIGS. 5-11 and the following description depict specific examples to teach those skilled in the art how to make and use the best mode of the invention. For the purpose of teaching inventive principles, some conventional aspects have been simplified or omitted. Those skilled in the art will appreciate variations from these examples that fall within the scope of the invention. Those skilled in the art will appreciate that the features described below can be combined in various ways to form multiple variations of the invention. As a result, the invention is not limited to the specific examples described below, but only by the claims and their equivalents.

FIG. 5 shows a removable window insulator 500 according to an embodiment of the invention. The window insulator 500 comprises multiple layers that are coupled together to form a single insulator 500. According to an embodiment of the invention, the window insulator 500 comprises a first layer 501, a second layer 502, and at least a third layer 503. The layers may be coupled together using any known means including adhesives, bonding, lamination, etc. According to an embodiment of the invention, the layers of the window insulator 500 may be permanently laminated together. The lamination may be accomplished by using an adhesive film, such as pressure sensitive or spray-on adhesives, or the lamination can be made by heat bonding methods. In another embodiment, the layers may also be quilted together by stitching. There also may be a gap between the layers to further improve the window insulator's thermal resistance.

In FIG. 5, an adhesive layer 504 is provided between the first layer 501 and the second layer 502 as well as between the second layer 502 and the third layer 503. Although the layer 504 is referred to as the "adhesive" layer, it should be appreciated that the layer 504 may not comprise an adhesive. Rather, the layer 504 may comprise any material suitable for coupling the various layers of the window insulator 500 together. Additionally, it should be appreciated that if the window insulator 500 is laminated, the adhesive layer 504 may be omitted.
It should be appreciated that the layers are not shown to scale, but rather the second, third, and adhesive layers 502, 503, 504 are shown as comprising approximately the same thickness. This is merely to aid in an understanding in the various layers of the window insulator 500. In practice, the layers will generally be much thinner than shown and the adhesive layers 504 may not be visible to the naked eye.

According to an embodiment of the invention, the first layer 501 comprises a thermal conduction insulating material to reduce the conduction of heat through a window. Therefore, the first layer 501 may comprise an insulation layer 501. This layer may comprise any number of insulating materials generally known in the art. Closed cell foam, such as polyethylene foam, open cell foams, such as polyester, or fibrous insulations such as glass or cotton fibers may be used. There are numerous other materials that may be used for the insulating layer 501 and the specific examples provided should not limit the scope of the present invention. The insulating materials that are suitable for the insulator panel as called for in this invention are commercially available. The choice of the insulating material for the first insulating layer 501 may be governed by the climate of the area where it is to be used. In colder climates a thicker insulating material may be more desirable whereas in moderate climates, thinner insulating materials may be sufficient. Ideally these insulating materials have a small thermal conductivity (k).

According to an embodiment of the invention, the second layer 502 of the window insulator 500 comprises a reflective material. Therefore, the second layer 502 may comprise a light reflecting layer 502. The second reflective layer 502 may comprise a reflective film, for example. The function of the reflective layer 502 is to reflect radiant heat back to the outside. This reduces the solar heat gain coefficient (SHGC) of the window insulator 500. The SHGC measures how well a product blocks heat caused by sunlight. The reflective film 502 may comprises aluminum foil, or aluminum deposited on a substrate, for example. Other reflective materials are generally known and may be used and the specific materials mentioned should not limit the scope of the present invention. The reflective film may also be deposited directly on the first insulating layer 501 or the third layer 503, for example.

In addition to the second reflective layer 502 reflecting heat away from the interior of the building, the second reflective layer 502 can reflect thermal radiation away from the first layer 501. This can prevent the first insulating layer 501 from absorbing heat.

According to an embodiment of the invention, the third layer 503 is adapted to couple the window insulator 500 to the glass surface of the window 104, the window frame 103, or the wall 102, for example. Therefore, the third layer 503 may be referred to as a coupling layer or a surface coupling layer, for example. The coupling layer 503 may be adapted to couple to any desired surface and the particular examples listed above should not limit the scope of the present invention. Furthermore, according to an embodiment of the invention, the third coupling layer 503 allows the window insulator 500 to temporarily and repeatedly be coupled to the desired surface. According to an embodiment of the invention, the coupling layer 503 allows the window insulator 500 to adhere to the glass surface of the window 104 as closely as possible. The coupling layer 503 may allow the window insulator 500 to stay coupled to the glass surface 104 until a user physically removes it. The coupling layer 503 may be coupled to the second layer 502, the first layer 501, or both.

The coupling layer 503 may comprise any number of different forms. According to one embodiment of the invention, the third layer 503 comprises a thin film of polyvinyl chloride (PVC), low density polyethylene (LDPE) or polyvinylidene chloride (PVdC). This film couples to glass and other smooth surfaces through mechanisms such as electrostatic attraction, vacuum, adhesion or cohesion. These films attach themselves to smooth non-conducting surfaces such as a glass window pane because they generate a Coulomb electrostatic charge upon mechanical handling. The window insulator 500 can be attached or removed from the glazing an infinite number of times using such a thin film layer. According to an embodiment of the invention, the coupling layer 503 may comprise a substantially transparent material. This allows the coupling layer 503 to comprise substantially the same size as the first and second layers 501, 502 without inhibiting the reflective characteristics of the second reflective layer 502.

FIG. 6 shows the window insulator 500 coupled to a window 104 according to an embodiment of the invention. As shown, the coupling layer 503 is coupled to the window 104. According to the embodiment shown, the second reflective layer 502 is exposed to the window 104. Therefore, thermal radiation can be reflected back through the window 104 and away from the first insulating layer 501 rather than being absorbed by the first insulating layer 501. Therefore, it is especially useful if the third coupling layer 503 and the adhesive layer 504 comprise substantially transparent materials such that at least a portion of the second reflective layer 502 is exposed to the window 104 when the window insulator 500 is in place.

It should be appreciated that the coupling layer 503 may not occupy the entire shape of the insulator 500. For example, in some embodiments, the coupling layer 503 can comprise one or more patches of arbitrary shape attached to the second reflective layer 502 intermittently at the periphery of the patch by a temperature resistant adhesive 720, for example (see FIG. 7). In some embodiments, the temperature resistant adhesive 720 attaches the third layer 503 to the second layer 502 and may not play any role in attaching the window insulator 500 to the glass pane. The intermittent deployment of adhesive 720 is to allow the pocket of air in between the third layer 503 and the second layer 502 to escape. This may allow greater coupling capability to the window, for example.

FIG. 8 shows the window insulator 500 according to another embodiment of the invention. In the embodiment shown in FIG. 8, the third layer 503 includes bleed holes 821 provided in the third layer 503 itself to allow the air to escape. In the embodiment shown in FIG. 8, the third layer 503 may be continuously bonded to the second layer 502. On a window insulator 500, several third layers 503 of arbitrary shape can be provided.

According to yet another embodiment of the invention, the third layer 503 may be continuously adhesively bonded to the entire second layer 502 except for certain patches where adherence to the glass surface is required. This implementation gives rise to the possibility that the third layer 503 may be screen printed for the desired pleasing appearance.

FIGS. 9A-9D show the third layer 503 according to another embodiment of the invention. In the embodiment shown, the third layer 503 comprises a plurality of suction cups 930. As shown in FIG. 9A, the suction cup 930 may
include a clip 931 or other attachment member to secure the suction cup 930 to the window insulator 500. In FIG. 9B, the suction cup 930 is coupled to the window insulator 500 using the clip 931 as well as an adhesive 932. Once the window insulator 500 is in place as shown in FIG. 9C, the suction cup 930 secures the window insulator 500 against the window 104 until a user desires to remove it. If additional securing is required, additional suction cups 930 may be coupled to the window insulator 500 such as shown in FIG. 9D where interior suction cups 933 are held in place using an adhesive 932, for example.

It should be appreciated that the suction cups 930, 933 may be held using other methods. For example, suction cups 930, 933 as well as other embodiments of the third layer 503 may be formed into the first layer 501 and/or the second layer 502. A portion of the first and second layers 501, 502 can be removed to make room for the third layer 503.

According to another embodiment of the invention, the third coupling layer 503 may comprise an adhesive, such as double sided tape, for example. According to this embodiment, one side of the adhesive could be coupled to the second layer 502, while the other side of the adhesive is coupled to the window 104. The adhesive may comprise patches as described above. Therefore, the adhesive does not need to occupy the entire second layer 502. In many embodiments, less adhesive may be desired because the adhesive may block a portion of the second layer 502, thereby inhibiting the reflective properties of the second layer 502. According to another embodiment of the invention, the third layer 503 comprises one or more magnets. A first portion of the magnet may be coupled to the second layer 502 while a second portion of the magnet can be coupled to the window or other surrounding surface. It should be appreciated that the third layer 503 may comprise other materials and the specific examples provided should not limit the scope of the invention.

According to another embodiment of the invention, the third layer 503 may be omitted and the window insulator 500 can be held in place by friction. The first layer 501 may be formed from a flexible material. The window insulator 500 can be sized slightly larger than the intended window opening so that when put in place, it is held in compression against the window frame. If sized properly, this could also create a substantially air-tight seal. According to an embodiment of the invention, the edges of the window insulator 500 may be contoured making the window insulator 500 more flexible without having to add a different material to the edges. Once the window insulator 500 is in place, the contoured edges can partially deform thereby holding the window insulator 500 in place.

According to an embodiment of the invention, the window insulator 500 may include a fourth layer 510 (shown only in FIG. 5). This layer can provide a decorative cover for the window insulator 500. Depending on the particular material chosen for the fourth layer, it may also function as a convection barrier to minimize air motion in the conductive insulating layer 501.

Although the window insulator 500 has been shown as comprising a substantially rigid material, in some embodiments, the window insulator 500 may comprise a relatively flexible component, thereby allowing the window insulator 500 to be rolled up or folded for storage purposes. In some embodiments, the window insulator 500 may be secured along one of the edges of a window, for example and unrolled into place. This may allow for easier use of the window insulator 500 while also providing a method for storing the window insulator 500 when not in use.

The window insulator 500 may significantly reduce energy requirements of a building. The insulation rating of a typical wood framed/fiberglass insulated wall is approximately R=15, whereas the insulation rating of a typical double pane window is approximately R=1.9. A window insulator 500 can have an R-rating of anywhere from 1 to 8 or more depending on the type of insulation used and thickness for the first layer 501. Calculations show that a window insulator 500 with insulation rating of approximately R=4 used on typical double pane windows can reduce heating cost by approximately 25%.

FIG. 10 shows the cost savings with the use of the window insulator 500 for a home with single or double pane windows. FIG. 10 is from a passive solar house in Boulder, Colo. area built in 1987 with 268 ft² of double pane windows. There are approximately 5730 heating degree days per year (HDD) in Boulder. The curves in this chart assume the house is heated with a 75% efficient oil furnace and heating oil is at $2.67 per gallon. Using the window insulator 500 on all windows after sunset, and on north facing windows during the day, the energy efficiency can be improved by reducing the heat loss through the windows. As can be shown in FIG. 10, the window insulator 500 with insulation of approximately R=2.0, would save approximately 0.86($/ft²)*268(ft²)$230 per year.

FIG. 11 is the same plot as FIG. 10 with the savings per square foot normalized per heating degree day, per $/gallon for oil. This allows you to calculate the savings for any part of the country and any cost of heating oil. The same house in Boulder with 268 ft² of window area, 5730 HDD/year, and oil at $2.67/gallon would save approximately $230 (0.000056 ($/ft²/HDD$/gallon)*268(ft²)*5730(HDD)*2.67($/gallon)≈$230).

Another way to look at these savings is to consider the total energy (for heating only) used in a typical building. In the example of this house, 476 thm (therms) per year are used for heating purposes. With the use of window insulator 500 savings, of 89.2 thm per year would be realized. A 95% efficient natural gas furnace, with natural gas at $0.95/thm would save approximately $85/year. For buildings with single pane windows, the savings are more than doubled. The window insulator 500 can be applied to any window at very low cost, and could have a return on investment of two years or less. Replacing the existing windows to triple pane windows, with R=3, is an expensive alternative, which would require many years to realize the return on investment. In contrast, using a window insulator 500 according to the present invention can result in savings that are realized much sooner.

The detailed descriptions of the above embodiments are not exhaustive descriptions of all embodiments contemplated by the inventors to be within the scope of the invention. Indeed, persons skilled in the art will recognize that certain elements of the above-described embodiments may variously be combined or eliminated to create further embodiments, and such further embodiments fall within the scope and teachings of the invention. It will also be apparent to those of ordinary skill in the art that the above-described embodiments may be combined in whole or in part to create additional embodiments within the scope and teachings of the invention.

Thus, although specific embodiments of, and examples for, the invention are described herein for illustrative
effective purposes, various equivalent modifications are possible within the scope of the invention, as those skilled in the relevant art will recognize. The teachings provided herein can be applied to other window insulators, and not just to the embodiments described above and shown in the accompanying figures. Accordingly, the scope of the invention should be determined from the following claims.

We claim:

1. A window insulator, comprising:
   a thermal insulation layer;
   a reflective layer coupled to the thermal insulation layer; and
   a surface coupling layer coupled to at least one of the reflective layer or the thermal insulation layer.

2. The window insulator of claim 1, further comprising one or more adhesive layers coupling the insulation layer to the reflective layer.

3. The window insulator of claim 1, further comprising one or more adhesive layers coupling the reflective layer to the surface coupling layer.

4. The window insulator of claim 1, further comprising a laminate coupling one or more of the layers together.

5. The window insulator of claim 1, further comprising one or more bleed holes formed in the surface coupling layer.

6. The window insulator of claim 1, further comprising a decorative layer coupled to the insulation layer.

7. A method for insulating an opening using a window insulator, comprising the steps of:
   reducing a thermal conductivity through the opening using a first layer of the window insulator;
   reducing a thermal radiation through the opening using a second layer of the window insulator coupled to the first layer of material; and
   coupling the first and second layers of the window insulator to the opening.

8. The method of claim 7, wherein the step of coupling the first and second layers of the window insulator to the opening comprises using a third layer coupled to at least one of the first or the second layers.

9. The method of claim 7, wherein the step of reducing the thermal radiation through the opening using the second layer comprises reflecting the thermal radiation away from the first layer.

10. The method of claim 7, wherein the first layer comprises a thermal insulation layer.

11. The method of claim 7, further comprising the step of reducing an air flow through the first layer by coupling a fourth layer to the first layer.

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