appeared on 7th Aug 2013

Doing it like mother nature

The right surface temperature helps keep the insides warm or cool, says S.Ananthanarayanan.

Nature provides ways for animals to adjust their skin temperature, so that they cool fast when it is warm or lose less heat when it is cold. Finding a way to do this for houses and buildings could save much cost in air-conditioning in the summer and heating in the winter.

University of Toronto Professor Ben Hatton and his colleagues at Harvard University and the Broad Institute, Cambridge, Massachusetts, report in the journal ***Solar Energy Materials and Solar Cells*** that they have created a surface to lay on glass windows, which has channels to carry water, like the narrow blood vessels that are found in the skin of animals. The mechanism is not the same as in animals, but the arrangement helps cool the window during hot weather, at any rate.

Ventilation and lighting of buildings calls for large windows and windows have glass window panes. While light streams through the glass and keeps the interiors well lit, glass blocks infra red radiation and soon heats up. Glass window panes of a building, on a warm day, can get as warm as the asphalt outside. The result is that the window panes radiate heat into the building, like large heating coils, to the discomfort of occupants, or burning up the owner, if there is air-conditioning, when she receives the energy bill. The authors of the paper say that of the total building energy costs, for cooling and heating, some 40% is estimated to arise because of windows.

Keeping cool

Natural systems, in form of warm blooded animals, in the same way as buildings, need to control internal temperature despite extremes in the temperature of the surroundings. Thus, the body needs to stay cool even when it is hot, or after exercise, and has to stay warm even when during a hard winter. Else, rising temperature would block vital processes, like the working of the brain, or there would be great energy loss in keeping warm, when it is cold outside. Natural systems have evolved to control temperature in the most efficient way, by controlling the surface temperature.

Thus, in warm weather when the body needs to lose heat, or receive less heat from the surroundings, the surface temperature, which is the skin temperature, is kept high, nearly the same as the temperature inside. But in the cold weather, when the body needs to lose the least heat possible, the skin temperature is kept low, well below the internal body temperature. The way the body manages this is by adjusting the diameter of the blood vessels that are right at the exterior, or the ***peripheral capillaries***. When temperature falls, the nervous system causes constriction of the capillaries and less warm blood flows at the surface. The surface of the skin is

thus cooler and there is less heat loss. On the other hand, if the body needs to lose heat, like after exercise or when it has a fever, or when the weather is warm, the surface temperature needs to be higher. The nervous system them widens or ***dilates*** the peripheral capillaries and more warm blood flows at the surface and the temperature rises.

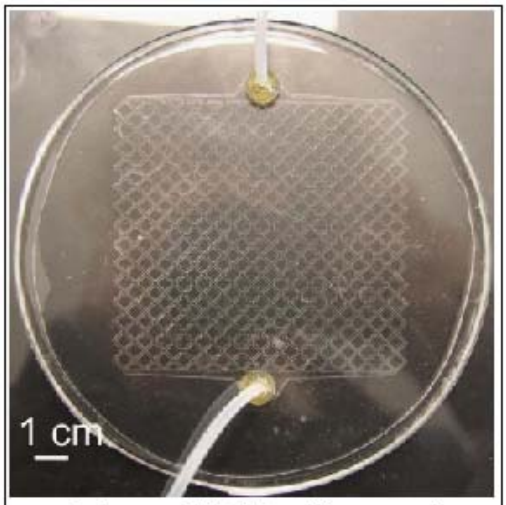
Alcohol and the capillaries.

Alcohol has the effect of dilating the peripheral capillaries. A stiff drink when one comes in from the cold would make the skin grow warm and this would warm up the wollen garment the person would be wearing, and the person would be comfortable. But that same drink taken when not securely wrapped up would lead to faster loss of heat and may prove harmful.

The story is told of soldiers or campers at high altitudes who have a drink before they get into their sleeping bags. The drink makes it uncomfortably hot and being a little drunk, the persons unzip the sleeping bags. If they are not careful to pull the zip back up, they may not wake up in the morning!

Persons who live in cold climates adapt, or generally have constricted outer capillaries, to conserve heat. When such persons visit warmer places, it takes the body some time to adjust and for a few weeks, or longer, these persons would find the heat difficult to bear. The converse is true when people from the plains take a holiday in the hills – they suffer from the cold and do not adapt till it time to come home again!

Window to saving power

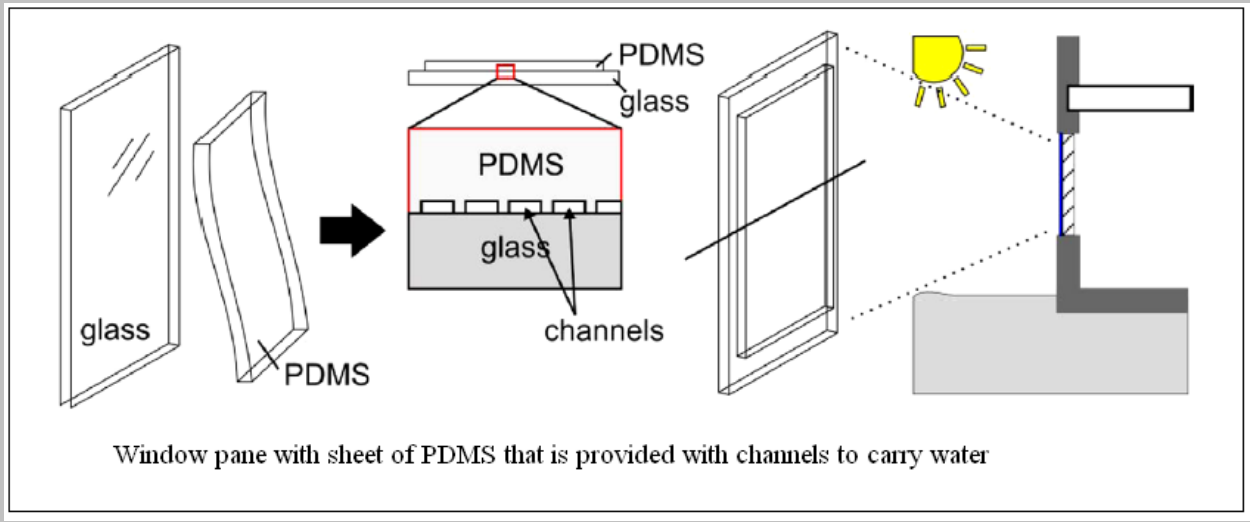


A piece of PDMS with a good number of microchannels

Ben Hutton and colleagues took a cue from nature and did the same things with glass windows. They created a plastic sheet, made of the material, ***polydmethylsiloxane*** (***PDMS***), a flexible and transparent material, and embedded narrow channels into the sheet. Water could be allowed to

flow through these channels so that the glass pane on which the plastic sheet was applied could be cooled. Room temperature water either began to warm and flow upwards, due to convection, or it could be pumped through the film. But the result in either case was that the glass pane cooled to almost the temperature within the building and no longer added to the heat load the interior had to handle.

The warm water flowing out of the film could be passed through a cooling tower or used for any warm water application or even with an energy recovery arrangement. During the winter, when windows cause loss of heat to the exterior, flowing water would stem the loss of heat by carrying it away for recovery and reuse. Ben Hutton and colleagues even suggest using coloured or stained water to control the level of light admitted, or for aesthetics.



Window pane with sheet of PDMS that is provided with channels to carry water

Solar Cells

While on subject of temperature control and energy saving, the solar cell is now an important source of non-polluting energy that depends on sunlight. The glass surface of the solar cell, like window panes, also warms in sunlight and the rise in temperature seriously affects the performance of solar cells. The loss of performance can be as high as 5% for every degree C. Ben Hutton and colleagues suggest using their PDMS film on solar cells to keep them cool and productive. As against saving energy used for air-conditioning, in the case of windows of buildings, this would be an application where the efficiency of energy generation is enhanced.