Solar Powered Air Conditioning

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In hot areas of the planet with high levels of daily sunshine, much electrical energy is consumed by air-conditioning systems, and much of this energy is obtained from fossil or nuclear fuels. It is possible to power the air conditioning system using only the incident solar radiation on the building and to maintain a comfortable internal temperature throughout the year without consuming any fossil fuel.

There are two ways to do this. The first is to use photovoltaic cells on the building roof to generate electricity and to use this to drive the air-conditioning system. The cells have an efficiency of about 17-20% and will require either a building with enough thermal mass to allow comfortable conditions to be maintained through the night, or a battery to store electricity for this purpose. This is probably the best solution to use in a pre-existing building. The other way is to use an ammonia absorption system in a purposely-designed building. This uses sunlight directly and could have an efficiency of about 22%. It is this latter option that is described in this document.

The ammonia absorption refrigeration system, (it used to be called the "Electrolux Cycle"), is well known and understood and will not be further described here. There are plenty of internet resources with clear practical explanations for those not familiar with the system. Some descriptions include a small liquid pump to move liquid from one part of the system to another, but most practical applications use gravity for this purpose and any building of more than a single storey would be tall enough for gravity to perform this task.

Each system requires a controllable heat input to an evaporator and a large heat exchanger section to release the waste heat. The building should be aligned east-west so that the front face of the building faces the sun. The roof is angled to face the sun and the evaporator is mounted on the single-slope roof. The back of the building is shaded from the sun and is used for the heat exchanger. To keep it shaded from the sun even in the early morning and late evening whilst maintaining a good air-flow over the heat exchanger, louvres are used around the edges of the rear face of the building to shade it from direct solar radiation whilst allowing a free flow of air. This heat exchanger may also be used to heat water in the building for washing, laundry, baths and showers. Another possibility is to connect it to a community-wide heat recovery system where it can be used to generate electricity, see the document: "Electricity from Disused Cooling Towers", see references.

The evaporator section needs to be heated to above 130°C intermittently. It is proposed that a parabolic trough mirror is motored to follow the sun, (photo-voltaic cells may be used to power this), and deflected to shade the evaporator from the sun when heat is not required. The control of the cooling provided by the whole system is achieved by regulating this heat input.

The chilling pipes need to be run within cylindrical holes through concrete floor/ceiling panels separating each floor of the house. These panels provide a large heat-sink so that cool temperatures can be maintained through the night and at other times when the sun is not shining. Temperatures in the building can be adjusted more quickly by circulating air through the holes in these concrete panels. Each chilling section needs to be on a single horizontal level, so each floor must have an independent complete ammonia absorption system

In worst case conditions, the outside shade air temperature could be over 45°C. It is theoretically possible to get a 40°C temperature difference between the condenser outlet temperature and the chiller temperature, however a more realistic difference of 28°C is easily achieved even in less than ideal circumstances. This will allow comfortable internal temperatures to be maintained throughout the year.

There is, of course, no heat input to the evaporator at night. The concrete floor panels need to be sufficiently massive to keep the building internal environment comfortably cool through the night. When the system is first installed, it may take a few days to chill these concrete floor panels sufficiently to make the building comfortable to live in.

The overall efficiency of the system is clearly heavily dependent on the quality of insulation of the whole building, which should be of a high standard.

References:

Electricity from Disused Cooling Towers, J. McCulloch, on www.intint.co.uk/environ