Solar Chiller: Zero-net energy for building air conditioning in hot climates

Introduction

The problem of global warming as a result of greenhouse gases emissions related with the growing world energy consumption and use of fossil fuels has concerned humanity. As a result, the use of renewable sources of energy has been increasingly considered. At the same time, an important aspect of achieving this goal is the development of technologies that allow for the efficient use of solar energy.

Results

After modeling the building and the system and carried out simulations in EnergyPlus, the following results were obtained:

Simulation 1

In the first simulation (original model), were obtained net energy values for June 21th (winter) and December 21th (summer) for each hours of the day. As a result, the PV energy production was lower than air conditioning energy consumption, as can be observed in the graphics below, with negative values of net energy. The main cause was the high consumption of auxiliary heating especially in times of lower solar radiation, that is, at the beginning and the end of the day.

Simulation 2

Adopting passive architectural techniques (east and west windows removed, roof thick doubled and windows north and south with double glazing), the net energy was considerably reduced but did not reach the net zero goal yet.

Simulation 3

Increasing PV efficiency (from 13.5% to 20%), the net zero goal was achieved in winter.

Conclusion

The following points can be concluded from this work:

1) The net zero energy air conditioning goal can be achieved only in winter in these regions, by associating solar thermal systems with absorption chillers and feeding the energy surplus with PV panels only if passive architectural techniques and high efficiency PV panels were adopted.

2) In order to increase the possibility of achieving the net zero energy goal for air conditioning systems, especially at an annual base, the following points should be taken into account:

   - using solar collectors that work at high temperature such as ETC, CPC or PTC so that double or triple effect absorption chillers with high COPs can be used.
   - developing solar chillers that work at lower temperatures so that the auxiliary heating energy consumption can be reduced.