Analysis of the performance of a GAX hybrid (Solar - LPG) absorption refrigeration system operating with temperatures from solar heating sources

International Conference on Solar Heating and Cooling for Buildings and Industry

San Francisco 9-11 july

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Introduction

Solar energy can be used to partially or totally produce the thermal energy required to operate absorption refrigeration systems during the day and to compensate in the night with a second resource such as biomass, waste heat or any other heat source and even a conventional cooling system.

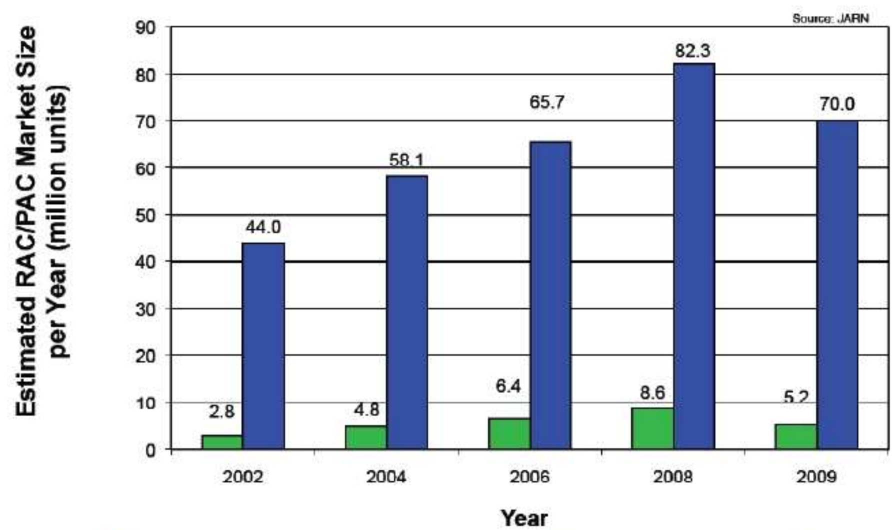
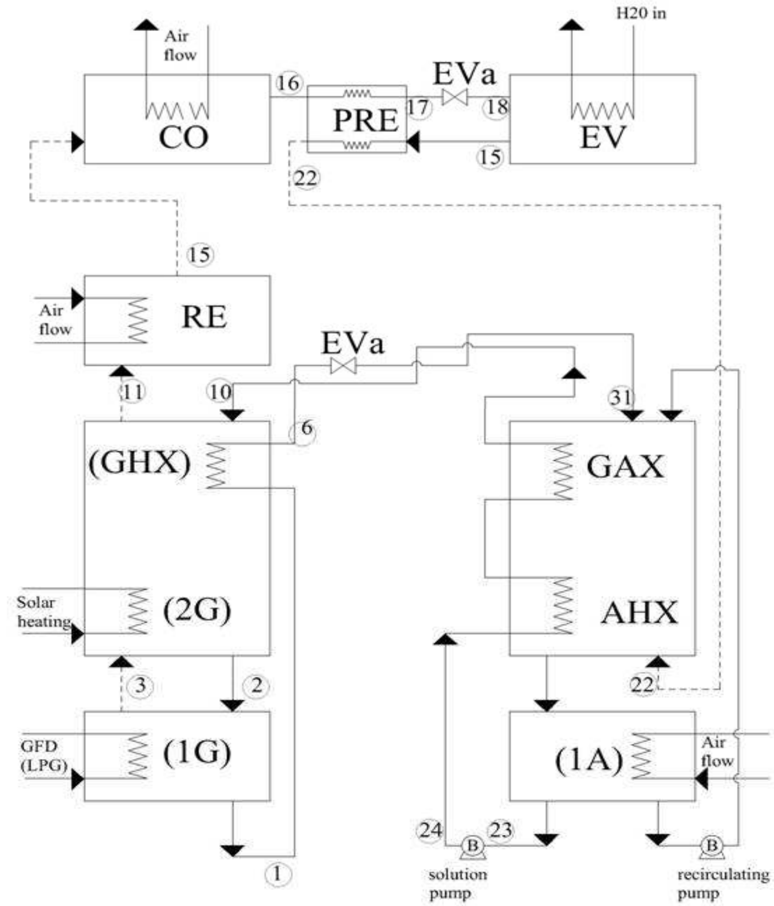


Figure 1: Evolution of air conditioning market worldwide (source: Jakob, 2010)

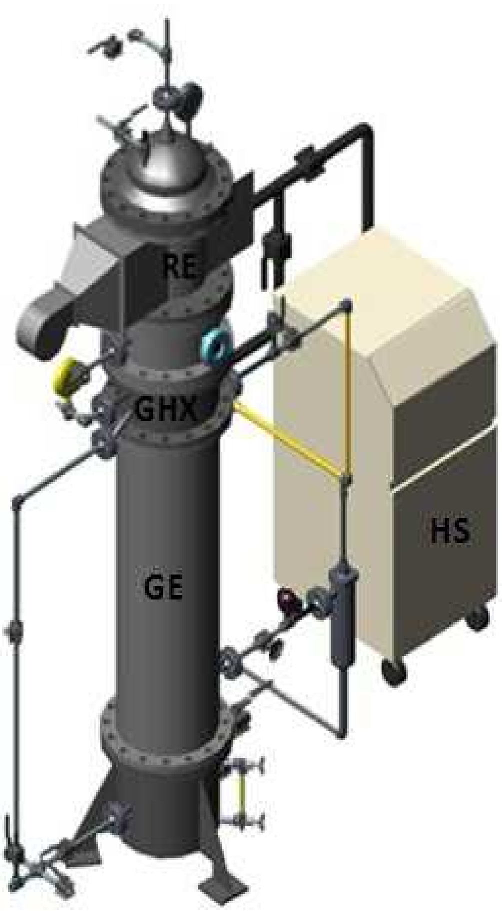
GAX system of the CIE-UNAM

- Operates with the binary mixture ammonia-water.
- Design capacity of 10.6 kW (3 tons of cooling)
- The Solar-GAX system consists of a generator, rectifier, condenser, evaporator, an absorber, two expansion valves, and a solution pump and three sections for heat recovery.
- The rectifier and the GHX heat exchanger section are coupled to the generator forming the generator-rectifier column.
- The coldest generator part, called GAX and AHX are coupled to the absorber forming to the absorber-GAX column.
- The Solar-GAX system does not require a cooling tower, because it is air cooled.
- This Solar-GAX system is configured to operate in a hybrid form with solar thermal energy and LPG or natural gas



GFD: Direct Fired Generator
GHX: Generator Heat Exchange
AHX: Absorber Heat Exchange

GAX system of the CIE-UNAM



Connections between the generator and the thermal oil heater.

Alternative system of generation.

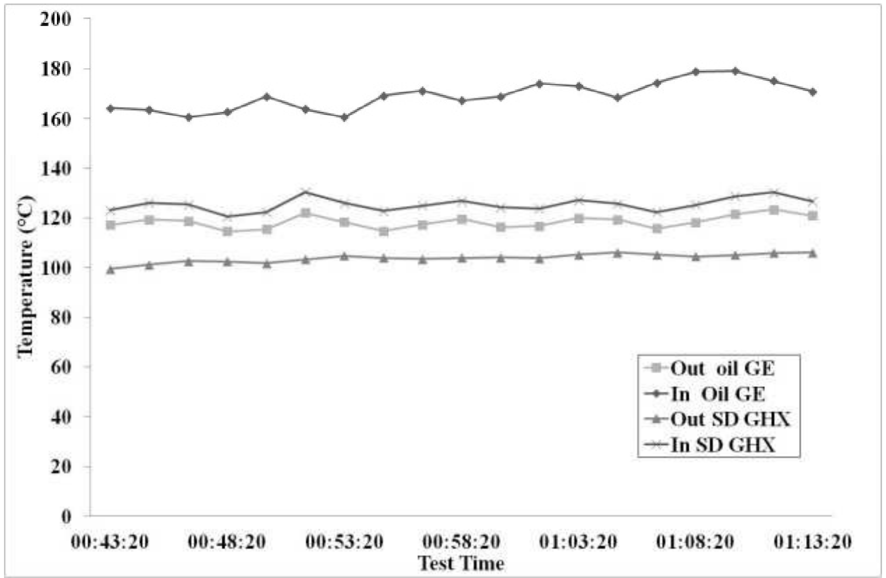
Objetive

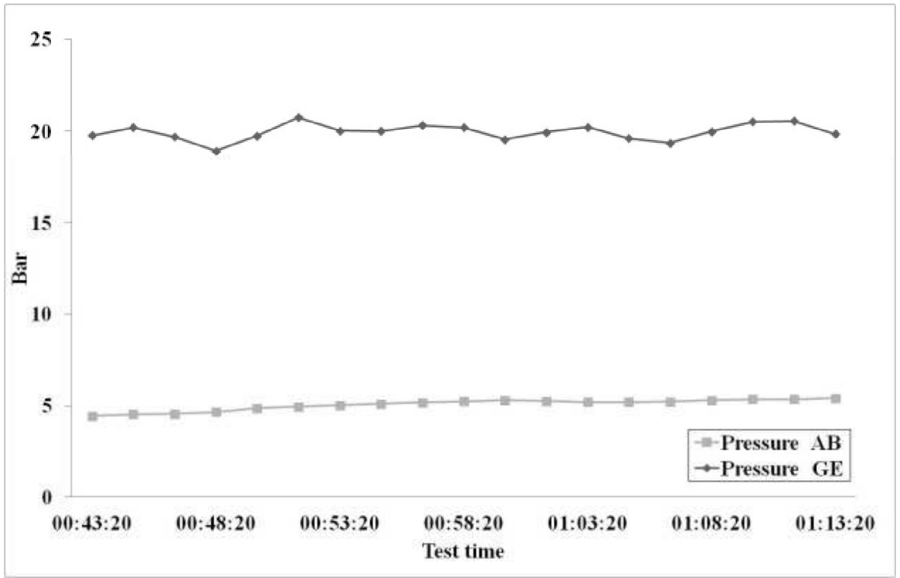
Characterize the behavior of the advanced refrigeration absorption system Solar-GAX.

Working fluid: Ammonia-water
Working temperatures: 120°C -140°C

Results

The heating source inlet temperature was around 160°C while the outlet temperature was below 120°C in the generator. Also shown are the weak ammonia solution outlet temperature that is also the inlet temperature to the GHX section, It can be seen that the solution leaves the GHX section around 100°C.

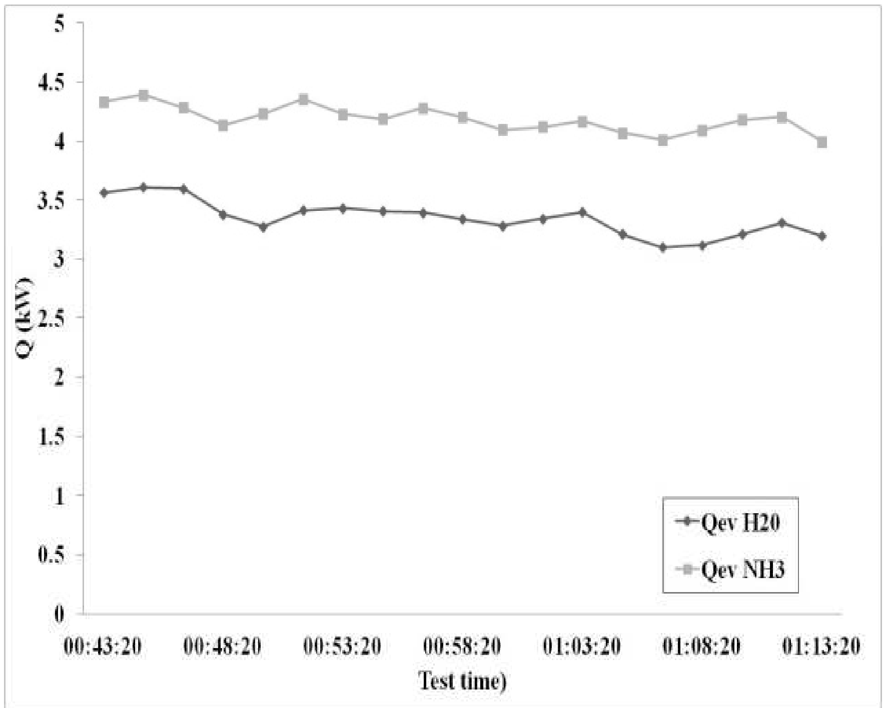


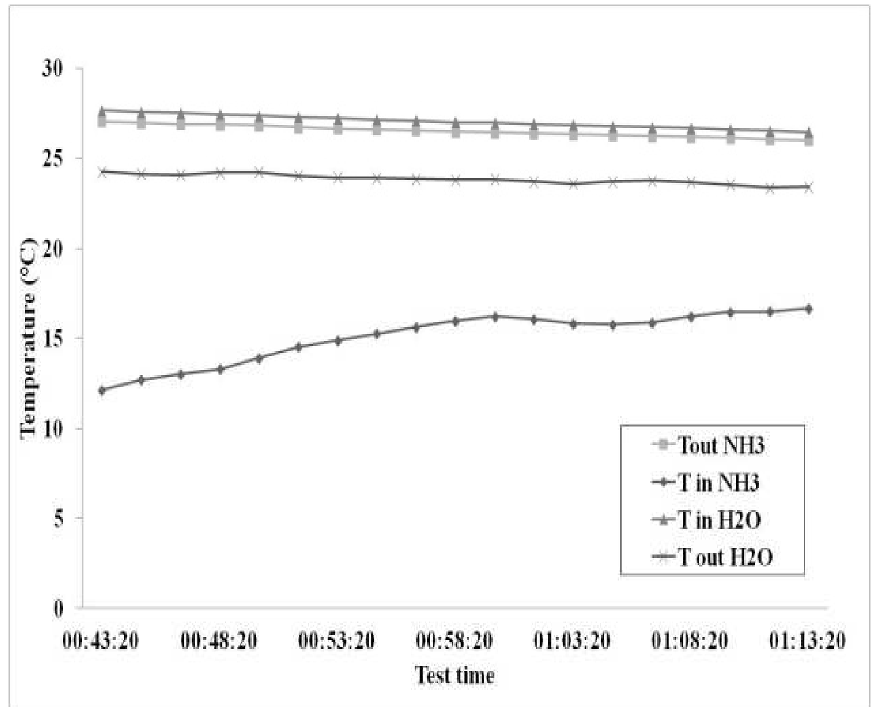


The working pressures are also shown.

Results

The cooling capacity reached was of 3.15 kW measured in the chilled water side and 4.2 kW calculated from an energy balance in the refrigerant side, were the ammonia is.

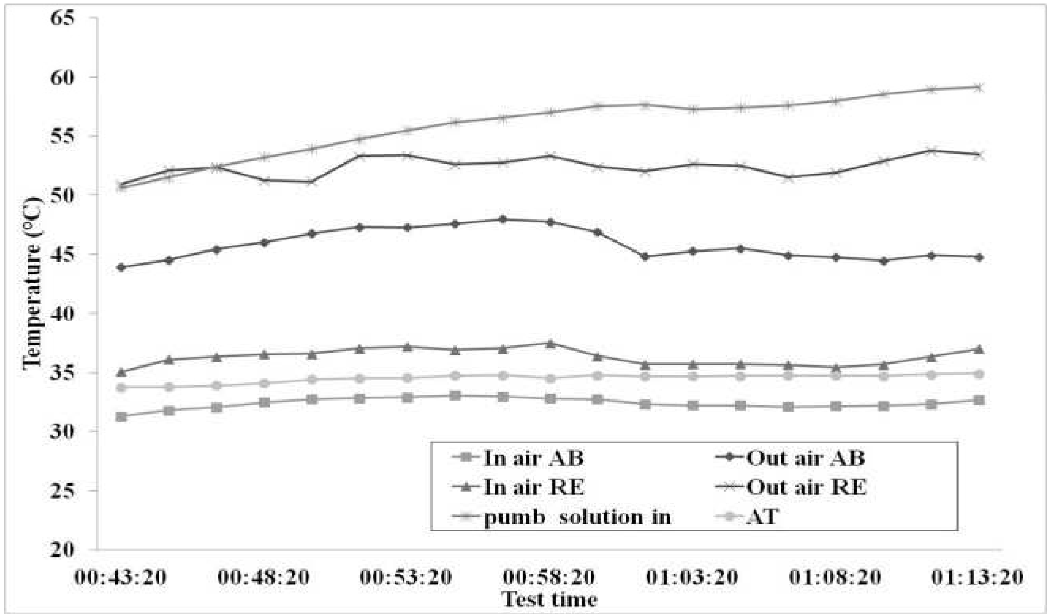




Inlet and outlet temperatures of water and ammonia

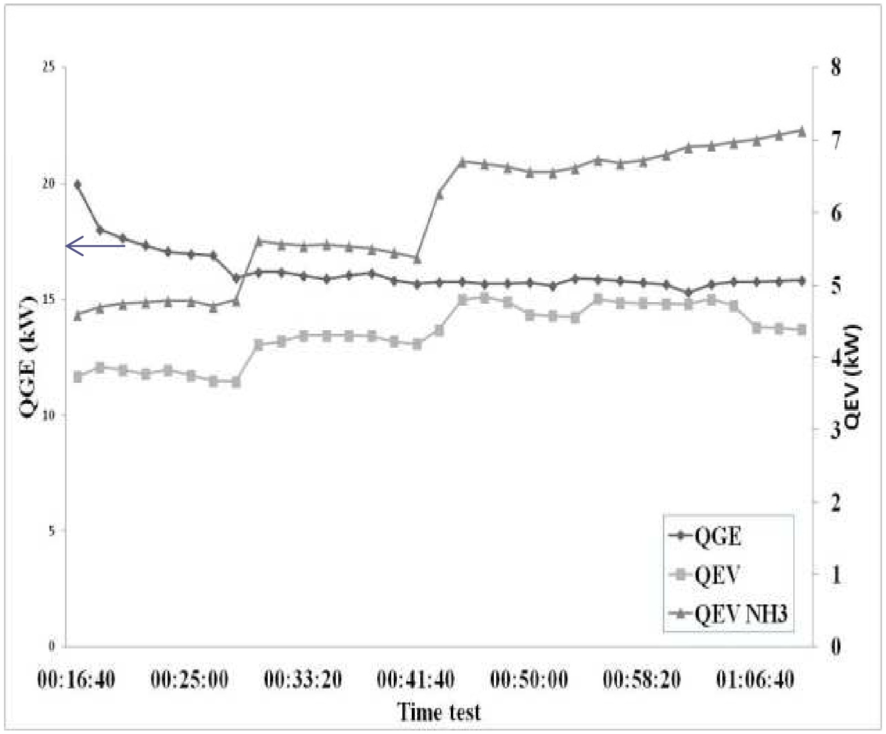
Results

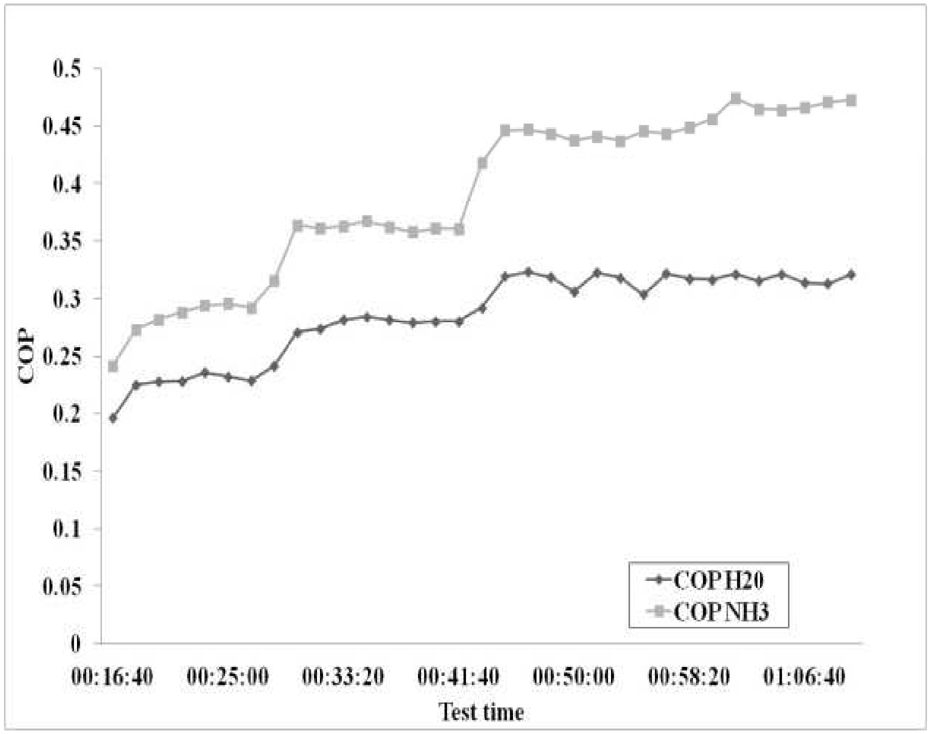
Figure shows the air temperatures during the test, it can be seen that the ambient temperature was higher than 30°C during the test. Local heat effects affect the inlet temperature to the absorber and rectifier.



Results

With higher solution temperatures (around 140°C) and ambient temperatures below 29°C a higher cooling capacity and COP were obtained.





Conclusions

- A partial load of 3.17 kW with a COP value of 0.15 was obtained when operating the Sol-GAX system at generator temperatures of 120°C when the design of the operating generator temperature was 200°C with a design capacity of 10.5 kW.
- The system was operated with a heat source temperature of around 160°C, so that can be obtained by concentrating collectors such as parabolic troughs or efficient CPC collectors.
- The air cooled absorption system was operated at ambient temperatures above 30°C.
- At an ambient temperature of 28°C, 7kW cooling capacity was achieved, with a mass flow of ammonia of 0.35 kg/min and a water flow rate of 15 kg/min, with temperatures of the diluted solution at 140 ° C and under these conditions a COP of 0.2 to 0.3 was obtained for the water side and 0.25 to 0.45 on the ammonia side.

Thanks

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