RP1002

# SOLAR ABSORPTION SYSTEMS FOR AIR-CONDITIONING APPLICATIONS IN LARGE-SCALE BUILDINGS IN AUSTRALIA

## Research Question

*How much thermal storage is required to meet demand and maximize utilizability of the solar collector array?*

*How can we design solar absorption systems to provide maximum payback?*

*What climates are suitable to solar absorption chillers coupled with concentrated solar thermal energy?*

*How can we optimize the performance of solar absorption chillers from energetic and economic standpoints?*

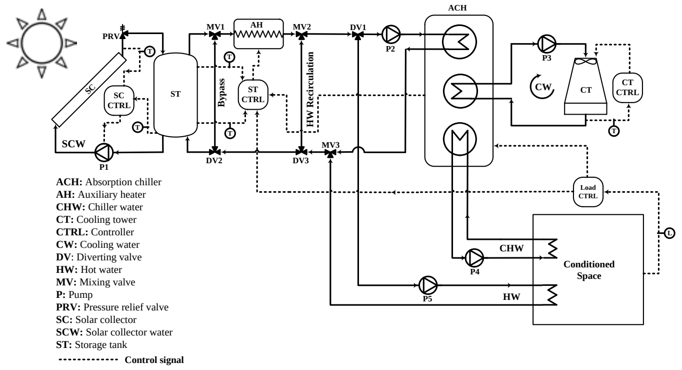


**Figure 1: Schematic diagram of a solar absorption chiller system**

## Methodology

A simulation model for each configuration is developed in TRNSYS 17. Different designs and operational modes are investigated.

A detailed evaluation of alternative backup options and the size of the absorption chiller is performed to determine the most energy efficient and economically profitable designs.

This research is still ongoing and further study on optimal performance of solar double- and triple-effect chillers is in progress.

## Results

The simulation results reveal that the solar fraction of the system is increased by 11% when a variable speed solar loop pump is used to achieve a collector set-point temperature adjusted according to the building load demand. Furthermore, a parallel configuration for the auxiliary heater out-performs a conventional series configuration.

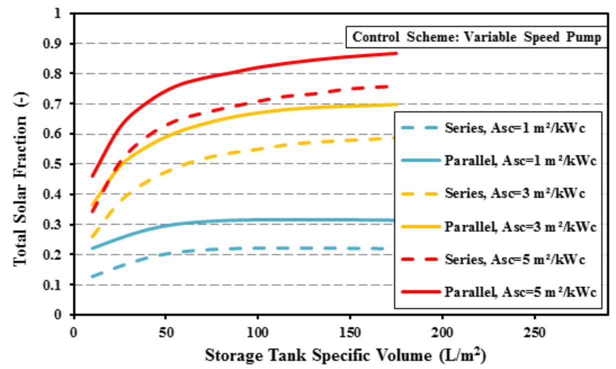


**Figure 2: The plant solar fraction for series and parallel auxiliary configurations at low, medium, and high collector areas**

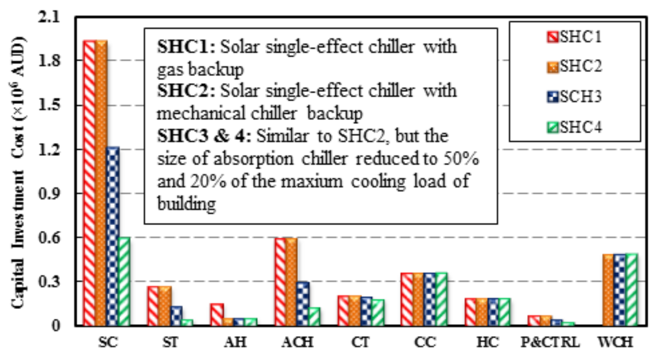


**Figure 3: Comparison of the capital investment costs of the proposed SHC configurations**

Moreover, the results show that using a gas-fired backup device in solar single-effect chillers proves to be significantly less energy-efficient relative to employing only the auxiliary mechanical chiller. Therefore, gas-fired backup systems should only be considered for solar *multi-effect* absorption chillers.

**Table 1: Sensitivity analysis of PBP (year), NPV (×106 AUD), and IRR (%) of the SHC configurations**

| Parameter | Subsidy (% of capital cost) 0% | 25% | +50% |
|---|---|---|---|
| **SHC1** | | | |
| PBP | 93.6 | 56.5 | 29.0 |
| NPV | −4.6189 | −2.9783 | −1.3376 |
| IRR | −8.2 | −5.4 | −1.1 |
| **SHC2** | | | |
| PBP | 94.5 | 50.6 | 23.8 |
| NPV | −5.4171 | −3.3690 | −1.3209 |
| IRR | −9.8 | −5.7 | −0.3 |
| **SHC3** | | | |
| PBP | 49.4 | 27.3 | 12 |
| NPV | −2.8816 | −1.4709 | 0.1601 |
| IRR | −5.8 | −1.4 | 5.6 |
| **SHC4** | | | |
| PBP | 36.2 | 16.6 | 4.1 |
| NPV | −1.2183 | −0.3248 | 0.5687 |
| IRR | −3.8 | 2.6 | 18 |

If 50% of the capital costs of solar collectors and chillers could be financed by government subsidies, then a design with undersized absorption chiller can be economically feasible, achieving a satisfactory payback period.

## Conclusions

- Higher solar fraction can be achieved by the control strategies and operational modes proposed here as compared to conventional designs, without adding a substantial capital cost to the system.
- A solar single-effect chiller with gas backup proves to be significantly inefficient due to its very low primary energy saving compared to a reference conventional system. Therefore, gas-fired backup systems should only be considered for solar multi-effect absorption chillers.
- The payback period of an undersized solar single-effect chiller can be reduced to about 4 years, if a government subsidy of 50% is considered.

## Anticipated impacts

This research will contribute to the International Energy Agency (IEA) SHC Program Task 48 (Quality Assurance and Support Measures for Solar Cooling Systems) to develop a theoretical groundwork for the energy-efficient design of solar heating and cooling (SHC) absorption systems for air-conditioning applications.

## Key statement

This project will reduce operational and financial uncertainties associated with solar heating and cooling in Australia, thereby providing a pathway to greater utilization of this technology.

For more information please visit:

http://www.lowcarbonlivingcrc.com.au/

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