was validated by *COP* profile shown in the figure—higher flow rate generally led to a higher *COP*. However, this phenomenon depended on the performance of the pump.

The pumping power during the cold release will be reduced if TBAB CHS is applied as the secondary refrigerant instead of chilled water due to its higher cold-carry capacity and thus the flow rate is lower. Fig. 7 presents the pumping power of water, 20 wt% CHS, 25 wt% CHS and 30 wt% CHS as the function of the cooling load during the cold release. As seen in the figure, more energy saving on pumping power was achieved by using TBAB CHS with higher mass fraction.

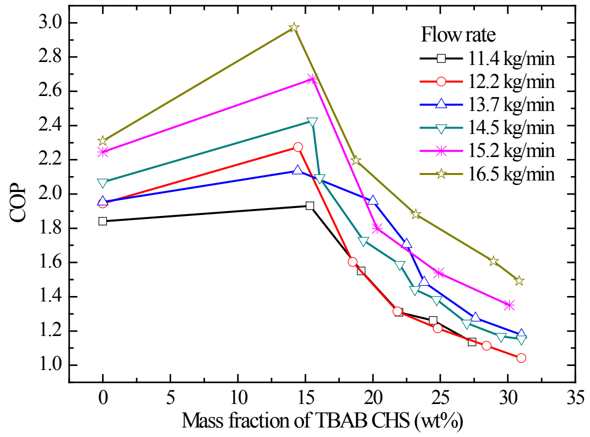


Fig. 6. System COP during the CHS generation.

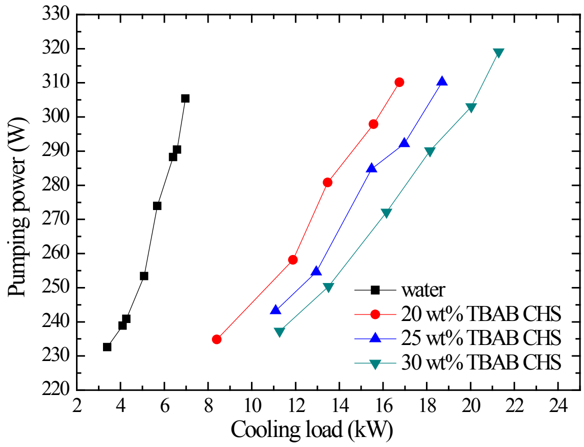


Fig. 7. Pumping power during the cold release.

A study case is assumed for better exhibiting the performance of TBAB CHS. The assumed cooling load is in eight hours in daytime, during which the average cooling load is 21 kW and the maximum value is 33 kW, therefore the totally cooling duty is 604800 kJ. Fig. 8 shows four types of system operation strategies. For each case, 20 wt%, 25 wt% and 30 wt% CHS are applied, the system *COP* during the TBAB CHS generation is about 2.10, 1.79 and 1.54, respectively based on the results in Fig.6 (flow rate: 16.5 kg/min). The storage ratio (which is the ratio of the storage cold energy to the total required cold energy) of case 1 and case 2 is 40% while that of case 3 and case 4 is 60%, the other cooling load is satisfied by the refrigerator (average system *COP* is about 2.32) while considering water as the secondary refrigerant. Moreover, assume the application of water as case 5 for the comparison, and consider water as the secondary refrigerant for all the cold release and no cold storage is conducted.

Fig. 9(a) shows the electric power consumption with all the study cases based on the present system. It can be seen from the figures, the power consumption increases as the increase of the mass fraction, which is obviously caused by the lower system *COP*. All the power consumptions in cases 1-4 are higher than that of case 5, which means there is no energy saving of the application of TBAB CHS compared with water. However, the operation cost does decrease as the increase of TBAB CHS mass fraction and the cost saving is shown in Fig. 9(b) (the price of the electricity is taken as 0.3 RMB/kWh during night time while 0.6 during daytime), about 8–27% cost saving can be achieved. However, since the the present system is limited by the room space, the piping from the storage tank to the load side is very short and thus the pumping power shown in Fig.7 is not coincident to the practical system with the assumed cooling load. Therefore, we re-calculate all the cases with amplifying the pumping power to 3 times as large as the present measured values during the cold release, the original case 1–5 become to case 1'–5'. Fig. 10(a) and (b) show the corresponding electric power consumption and the cost saving. It is noticed that about 1.4–3.5% energy saving is achieved, calculated by 20 wt% TBAB CHS with all the operation strategies, while the cost saving increases to about 10–29%.

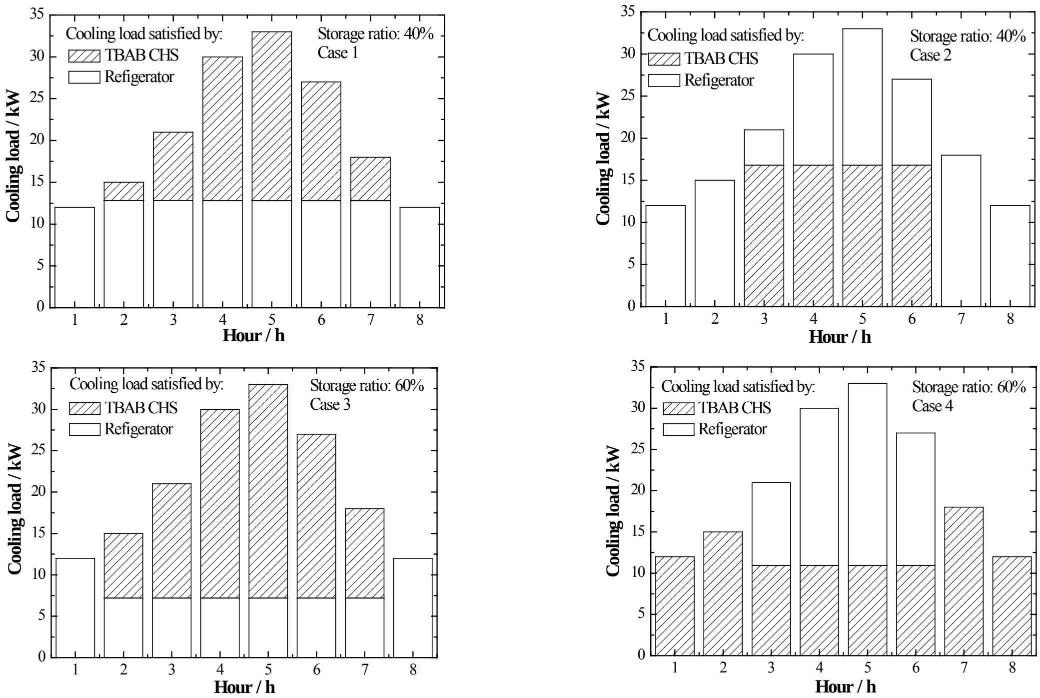
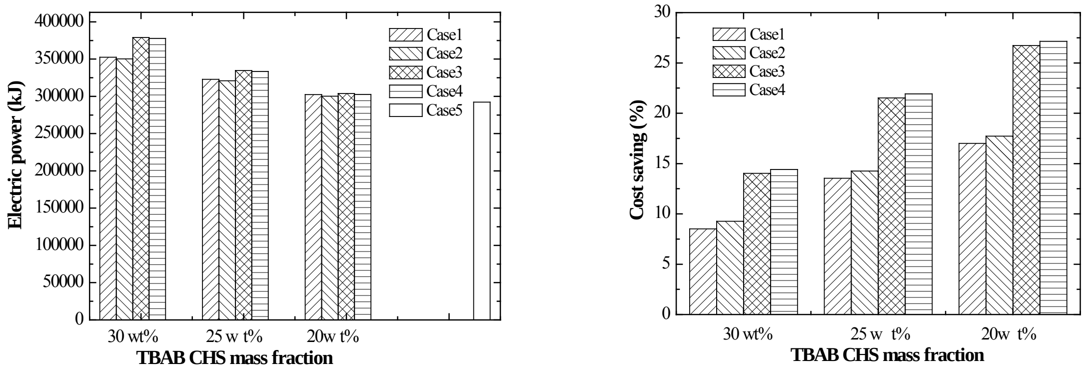


Fig. 8. System operation strategies.

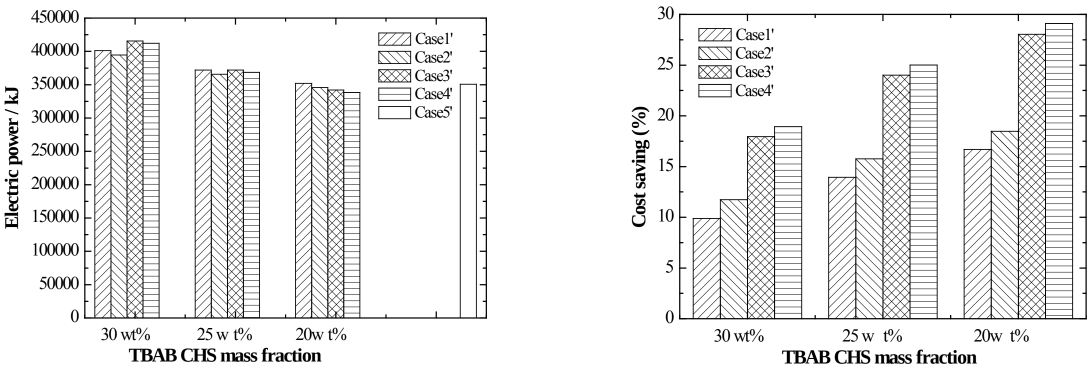


(a) *(b)*

Fig. 9. Electric power consumption and cost saving.

4. Conclusion

The present work mainly constructed and tested a cold storage air-conditioning system using TBAB CHS and estimates the energy consumption. The system *COP* decreased from about 1.92–2.95 to about 1.05–1.49 during CHS generation. The energy saving by using TBAB CHS instead of water was not achieved as expected since the piping was short and the pumping power was low in the present system, while 8–27% cost saving was achieved. However, about 1.4–3.5% energy saving could be achieved if the pumping power was amplified to 3 times as large as the original values, meanwhile the cost saving was about 10–29%.



(a) *(b)*

Fig. 10. Electric power consumption and cost saving with amplified pumping power.

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