Heat output of heat exchanger

Figure 9 shows outlet temperature from heat exchanger to cascade loop. The difference between the simulation and the measurement is about 0.3～0.5°C. The outlet temperature during operation is approximately 73°C and cannot be reached 75° C because water temperature thermal storage tank is not higher (74°C～76°C).

Figure 10 shows heat output of heat exchanger. The simulation results are 20% larger than the measurement. The reason of the difference between simulation results and measurement is the discrepancy of outlet temperature from heat exchanger to cascade loop. To improve the accuracy of the prediction such as heat output of collector, pump flow rate and heat loss from heat exchanger is conceivable to be important. Efficiency of solar utilization η_{esu} of measurement was 60%, and that of simulation is 72%.

Figure 11 shows inlet flow rate of heat exchanger from cascade loop. The flow rate of Pump 3 shows good agreement with the calculated results and the measurement.

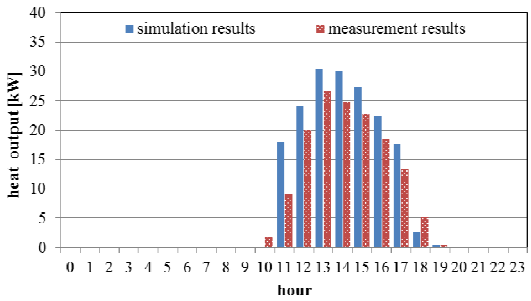

Fig.10 heat output of heat exchanger

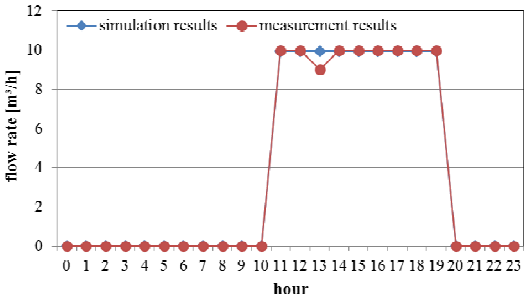

Fig.11 Flow rate of heat exchange from tank

Impact of solar collector allay pattern

Figure 12 shows collected heat of evacuated solar collector depending on collector allay pattern. The daily collected heat of 4parallel system (4p) is 242 kWh/day. The daily collected heat is 239 kWh/day (99%), 236kWh/day (97%) in case of the 2parallel-2series system (2p-2s) and the 4 series system (4s) respectively. Collected heat of the 2p-2s and 4s system is slightly less than that of 4p system.

Figure 13 shows outlet water temperature of collector. The outlet temperature of 2p-2s system is about maximum 8°C higher and that of 4s system is about maximum 18°C higher than that of 4p system. In case of 4s system, higher output temperature can be gained considerably.

Figure 14 shows average water temperature of thermal storage tank. The average water temperature of 2p-2s system is about 1°C higher than that of 4p system, and that of 4s system is about 2°C higher from 9:00 to 14:00. However after 14:00, the average water temperature is similar in all system. The rise of average water

temperature depending on allay patterns cannot be generated due to installation of mixed type thermal storage tank.

Figure 15 shows heat output of heat exchanger. The efficiency of solar utilization η_{esu} of 2p-2s system can be up to 87%, that of 4s system can be achieved at 92%.
To improve efficiency of solar utilization, it is necessary to investigate heat output in case of installing thermal stratification type storage tank or direct loop without storage tank instead of mixing storage tank.

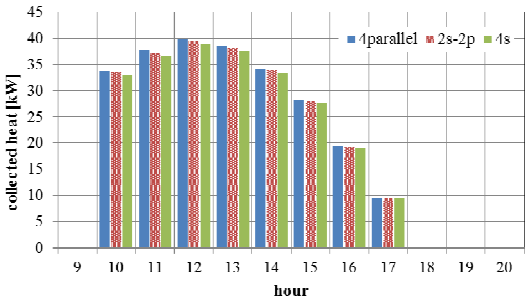

Fig.12 Collected heat of collector

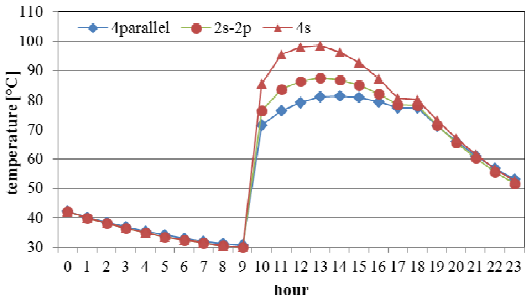

Fig.13 Outlet temperature of collector

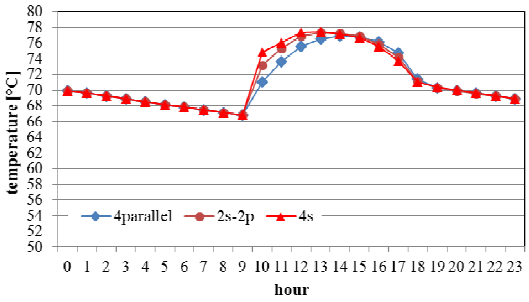

Fig.14 Average temperature of storage tank

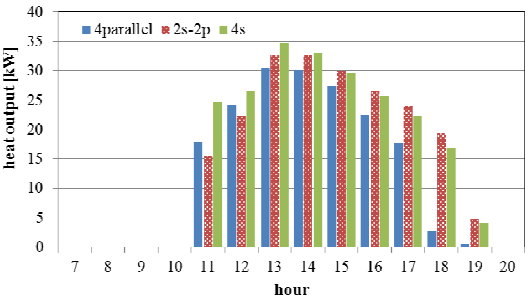

Fig.15 Heat output of cascade loop

CONCLUSION

In this paper, analysis and evaluation of the system performance of solar thermal system integrated in parallel with co-generation are conducted by field measurement and simulation. The Simulation results of solar collector system have good agreement with the measurement results. To improve the accuracy of the prediction such as heat output of collector, pump flow rate and heat loss from heat exchanger is conceivable to be important. With this verified simulation model, the sensitivity of array patterns of solar thermal collector is analyzed and efficiency of solar utilization is examined. The efficiency of solar utilization is 72% in 4 parallel system and up to 87% in 2p-2s system., The best efficiency is 92% achieved by 4s system.

References

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