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Efficient Energy Use

Exergy analysis of heat pumps

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Goal

The study analysed the energy efficiency of a compressor driven heat pump (CDHP) and an absorption heat pump (AHP) using two different exergy analysis methods.

Methods

The first method was based on the calculation of the entropy generation rate over the system and the use of effective heat absorbing and emitting temperatures.

For the CDHP the efficiency is $\eta_1 = \frac{W_{min}}{W_{real}}$

For the AHP the efficiency is $\eta_1 = \frac{W_{loss,min}}{W_{loss,real}}$

The second method was based on the calculation of exergy balances over the system and the use of the reference environment.

For the CDHP and AHP the efficiency is $\eta_2 = \frac{Ex_{out}}{Ex_{in}}$

Results

The analysis was made for two case studies (Figs. 1 and 2). In both cases the heat demand was 84kW and the outdoor temperature -7°C.

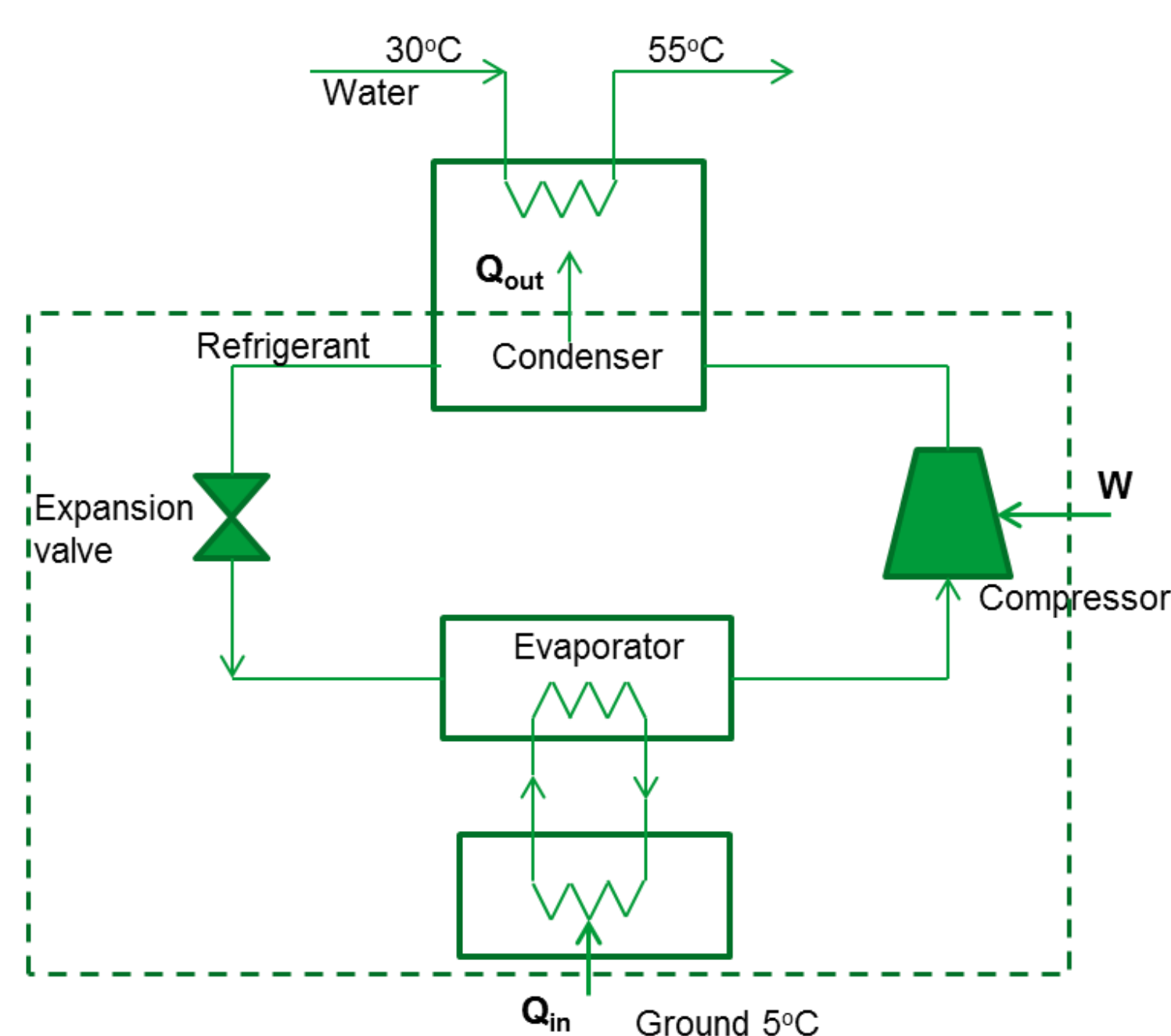


Fig 1. A compressor driven heat pump

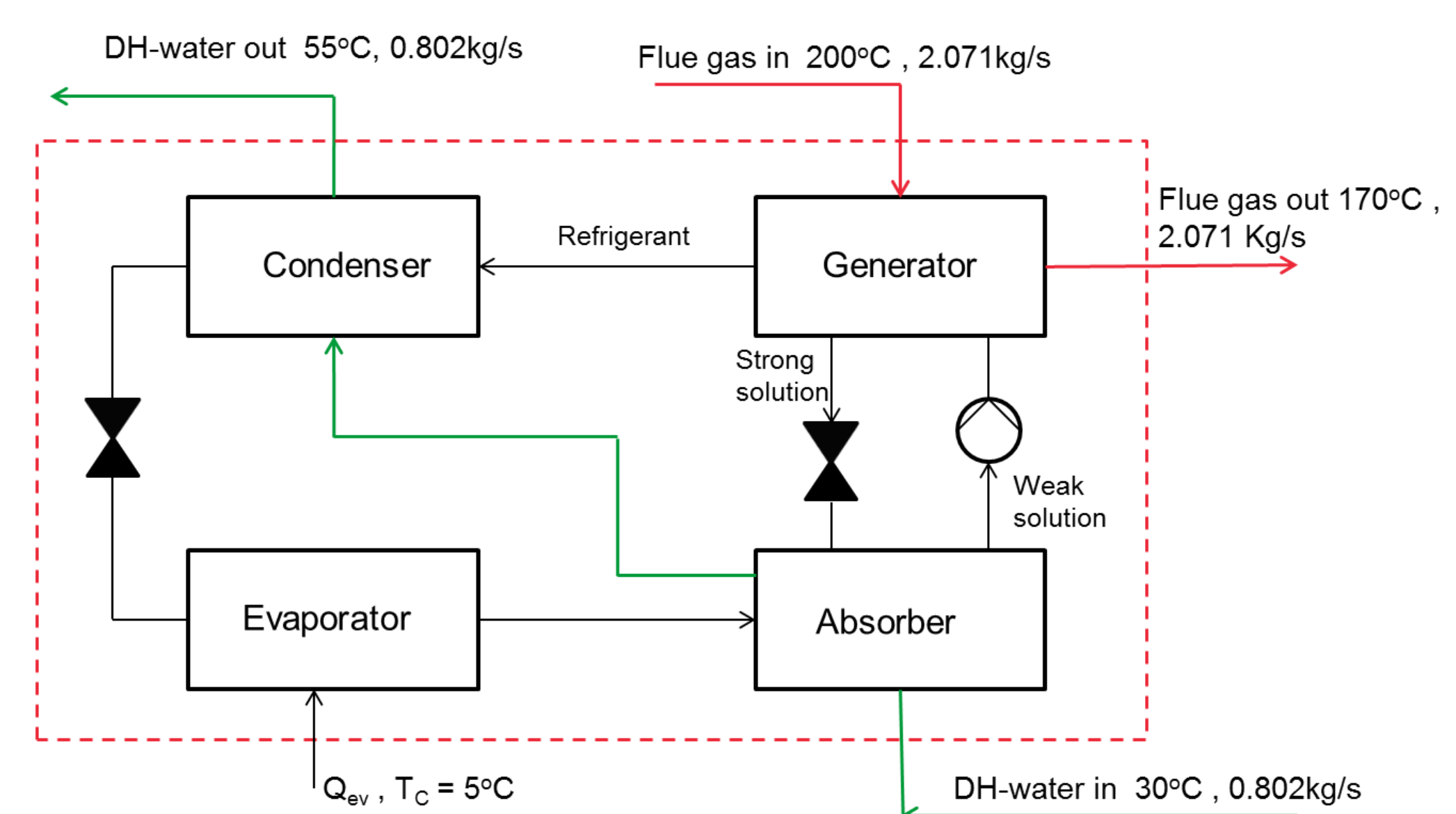


Fig 2. An absorption heat pump

Table 1 shows the results of the study

Table 1. Results of the study

Heat pump	Q_{DH} kW	W_{min} kW	W_{real} kW	COP_{real}	COP_{max}	η_1 First method	η_2 Second method
Compressor driven heat pump	84	9.94	21.1	3.51	8.45	0.471	0.53
Absorption heat pump	84	9.94	27.4	1.32	1.32	0.363	0.18

Conclusions

For a compressor driven heat pump, the exergy analysis makes it possible to define a maximum value for COP.

For a compressor driven heat pump, the exergy analysis assess the energy efficiency in the same way as the conventional COP.

The conventional COP of an absorption heat pump is solely based on the First Law. In this case, the exergy analysis evaluates the energy efficiency in a more objective way than the currently used COP value

In conclusion, the exergy analysis is the recommended evaluation method of energy efficiency, and especially in the case of absorption heat pumps.

