**Online appendice**

**Analytical solution**

The heat pump coefficient of performance (COP) in heating mode is defined by Eq. 2 while the one in cooling mode is defined by Eq. 3 [7]. They correspond to the COP of a Carnot system multiplied by a factor (*g*) taking into account all the irreversibilities and physical constraints.

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The Rankine cycle (RC) efficiency is defined by the Carnot efficiency multiplied by a factor (*g*) taking into account all the irreversibilities and physical constraints (Eq. 4 [7]).

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It is conventionally accepted that *g* is comprised between 0.5 and 0.7 to obtain performance that match real applications [7]. In the case of the hot storage architecture, the roundtrip efficiency is simply evaluated by the product of the COP and the efficiency of the power cycle (Eq. 5) in which *Qev* is the thermal energy at the evaporator.

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In the case of the cold storage, the roundtrip efficiency is defined by Eq 6 where *Qcd* is the thermal energy at the condenser.

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A simple analytical model based on Eqs. 2-5 provides the ratio of the roundtrip efficiencies between the cold and hot storage layouts (Eq. 10). The demonstration is provided through (Eqs. 6-9). For the simplicity of the formulation, *g* is assumed to be equal in Eqs. 2-4.

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This ratio (*R*) is always below one since the lift, *ΔT* (assumed equal for hot and cold storage) is larger than 0 and *g* is by definition comprised between 0 and 1.

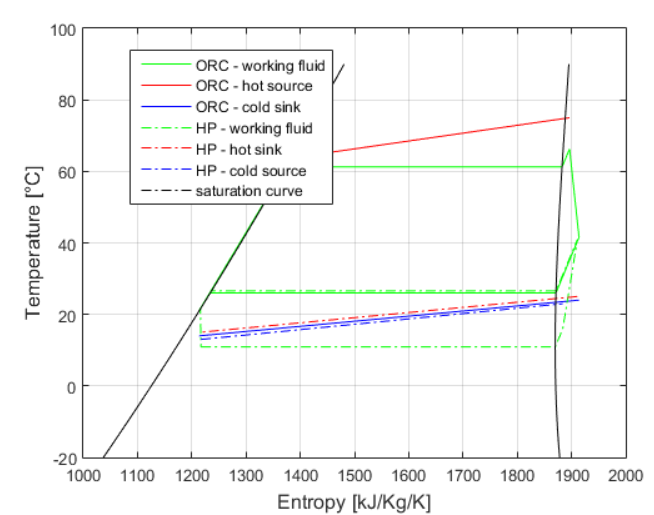


Figure 1: Example of T-s diagram for a cold storage configuration.

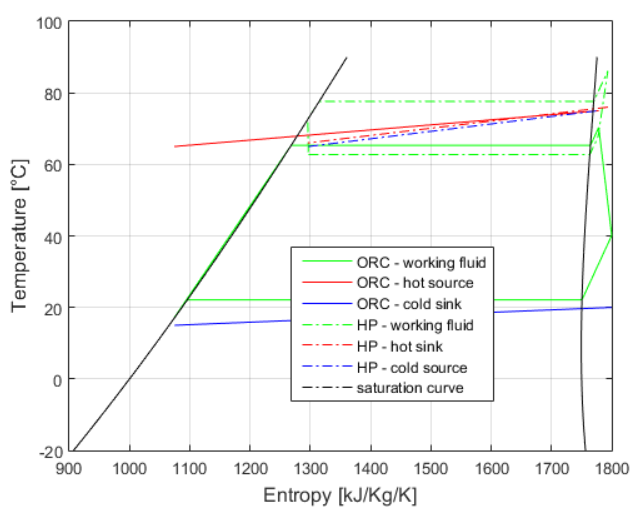


Figure 2: Example of T-s diagram for a hot storage configuration.

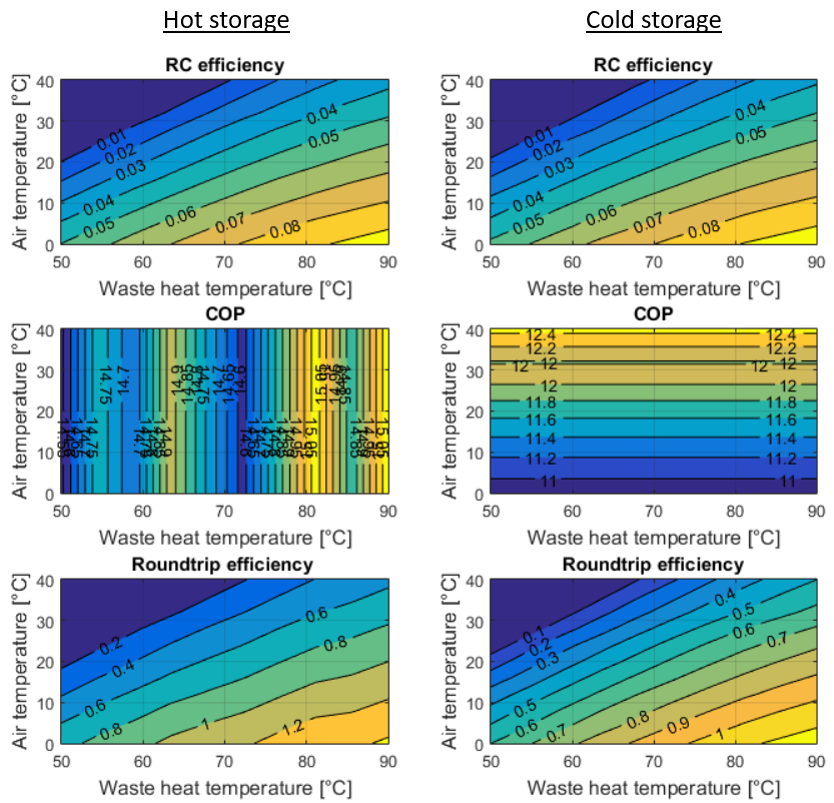


Figure 6: ORC efficiency, COP of HP and roundtrip efficiency as a function of the air temperature and the waste heat temperature (glide = 10 K, fluid = R1234yf).

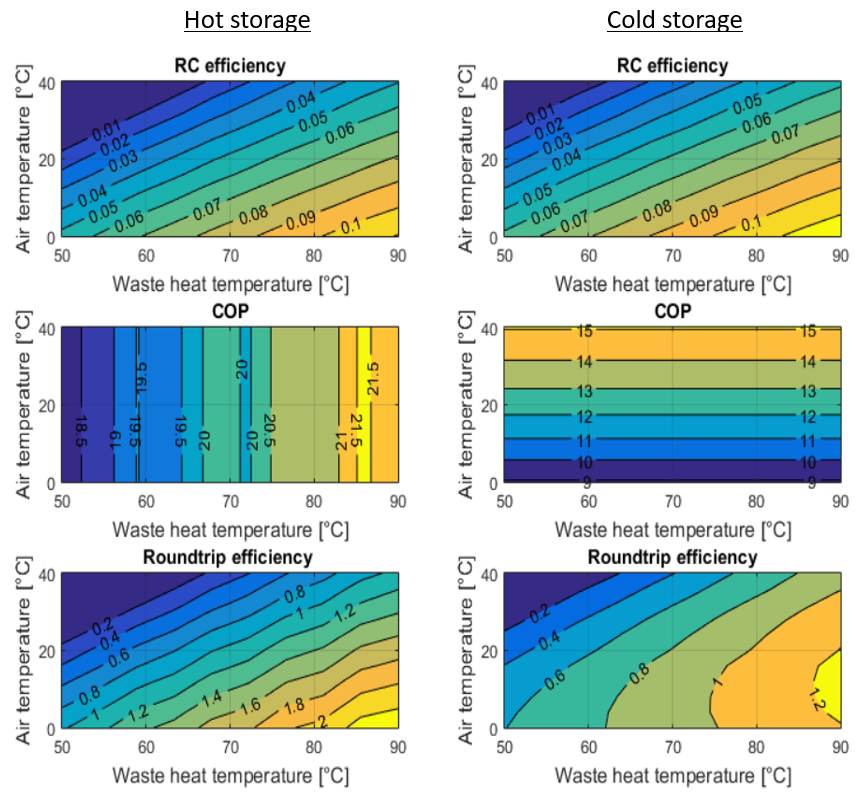


Figure 7: ORC efficiency, COP of HP and roundtrip efficiency as a function of the air temperature and the waste heat temperature (glide = 5 K, fluid = R1233ZD(E)).

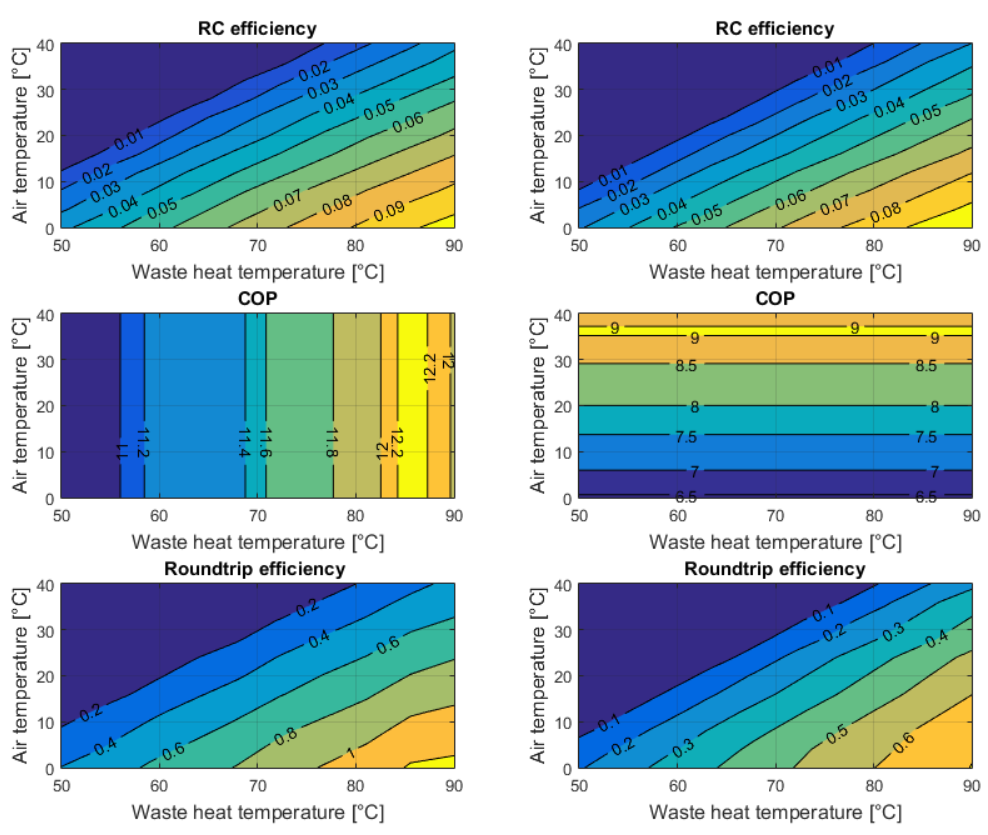


Figure 8: ORC efficiency, COP of HP and roundtrip efficiency as a function of the air temperature and the waste heat temperature (glide = 15 K, fluid = R1233ZD(E)).