Province de Liège
Enseignement

Organic Rankine Cycle

Course: Buildings and HVAC Systems 2nd Master
Academic year: 2013-2014
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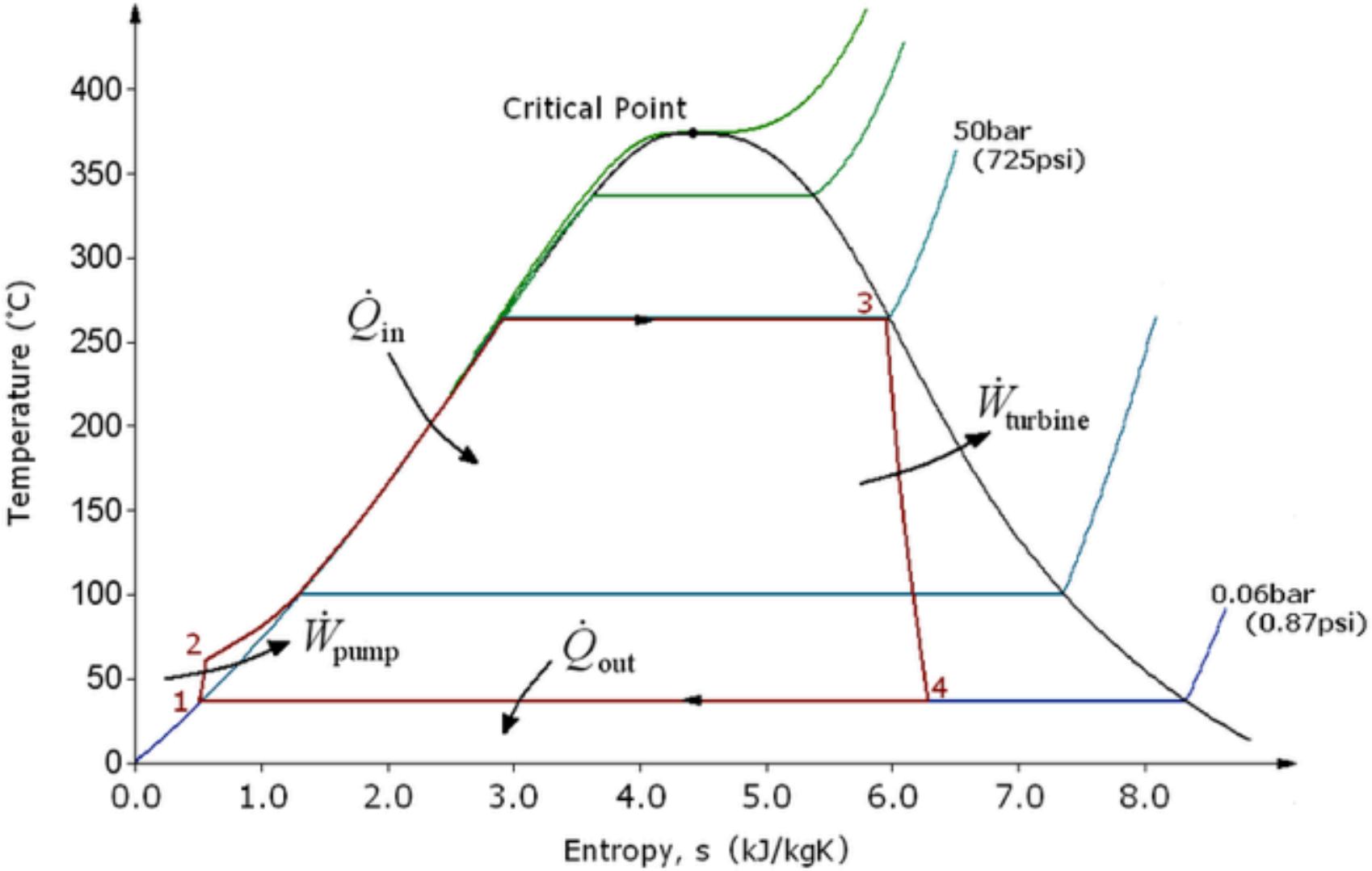
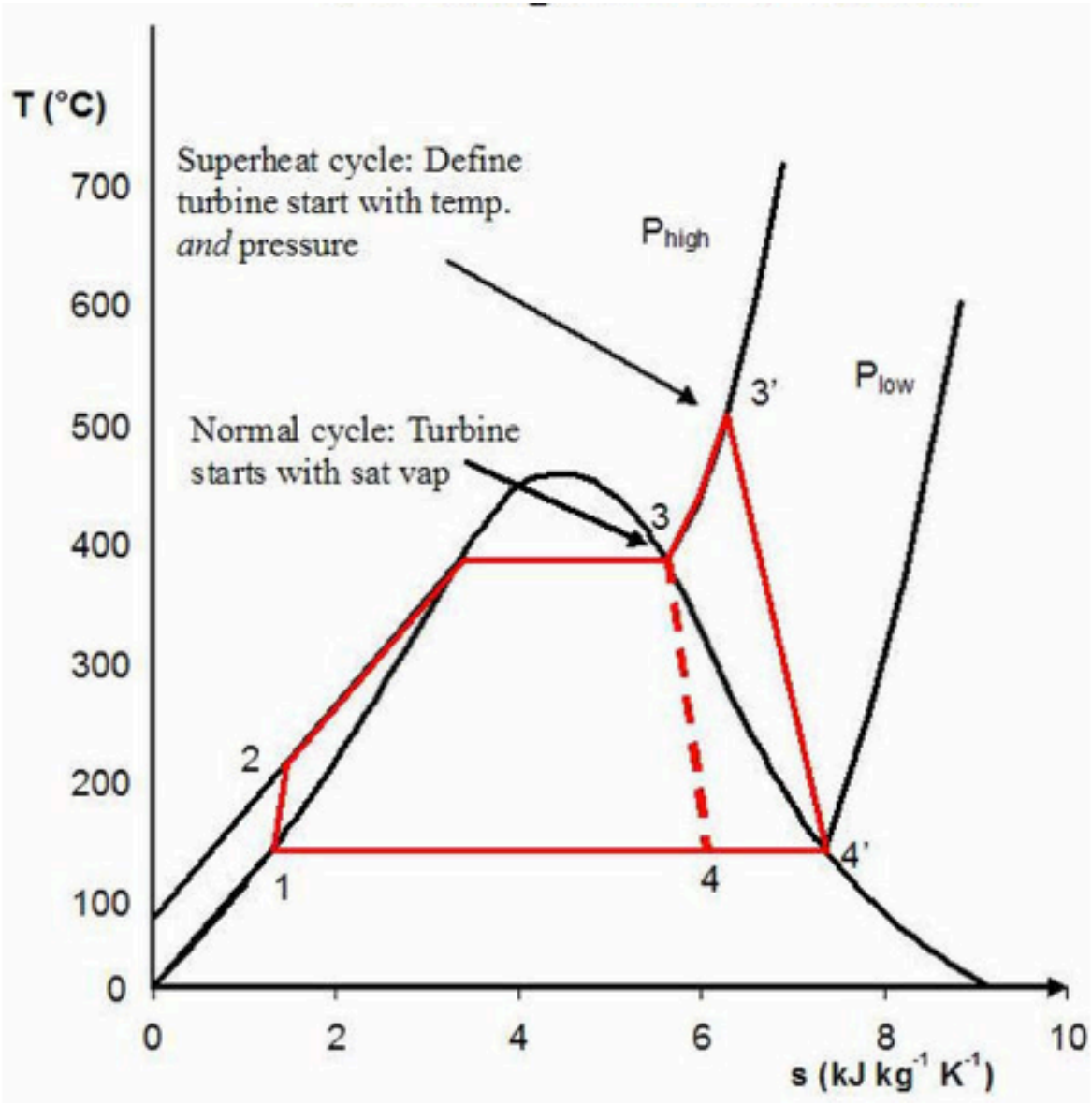
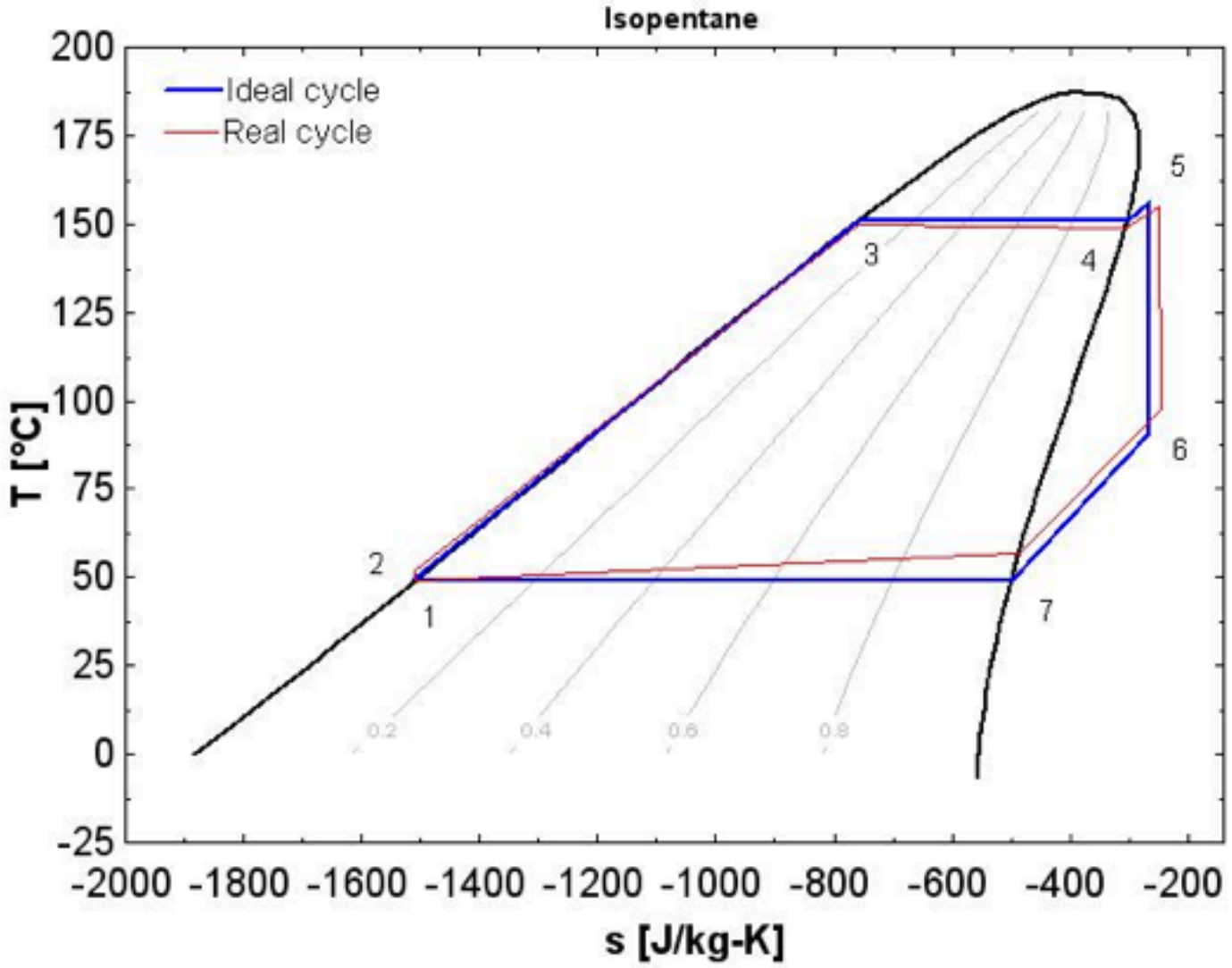
Rankine Cycle :



Real power plant cycle (the name 'Rankine' cycle is used only for the ideal cycle)



ORGANIC Rankine Cycle :



Working fuids

water is « free », with no risk for men and the environment and this water has been used since 18th century for thermodynamic cycle applications.

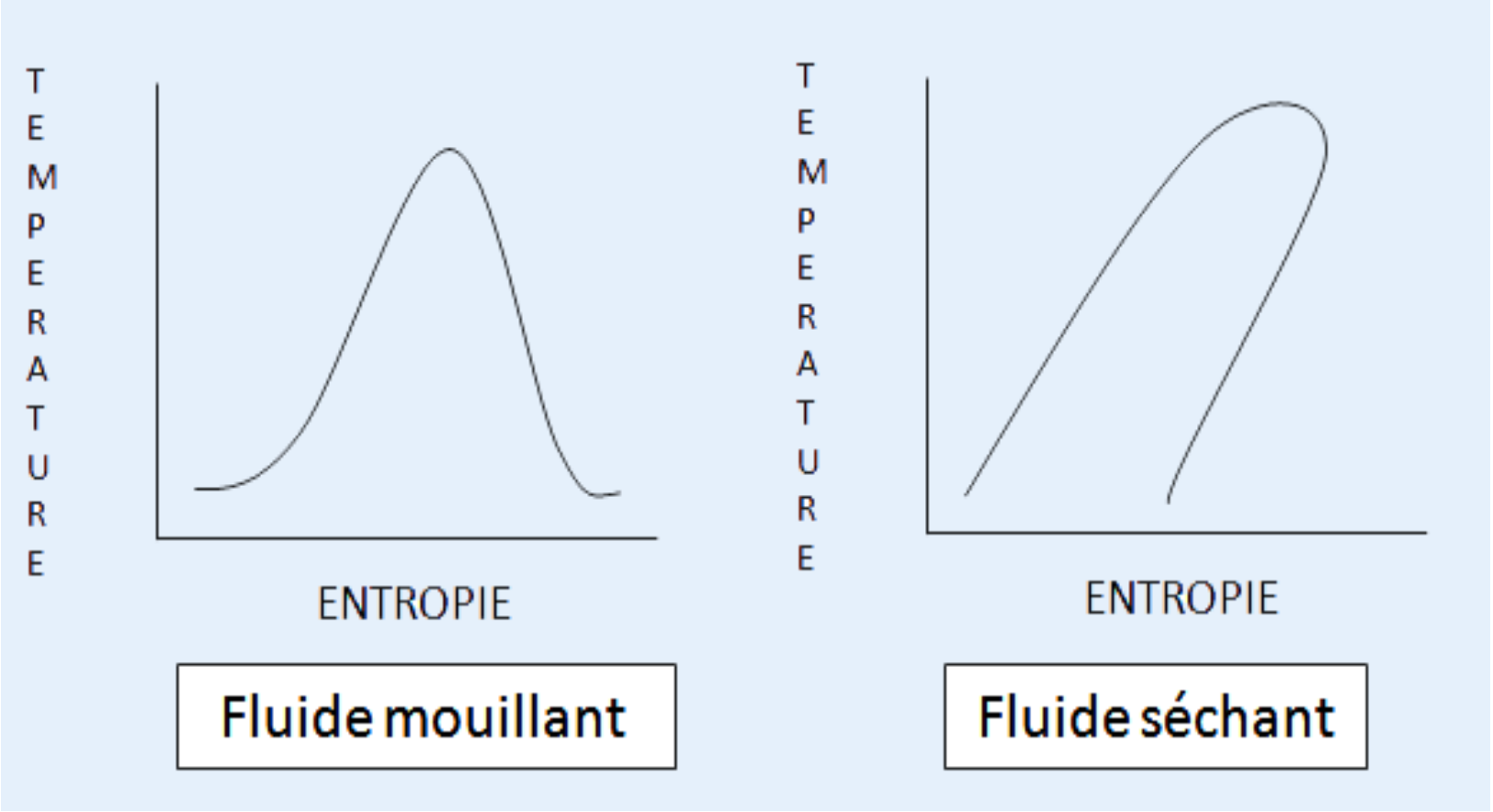
So, why change?

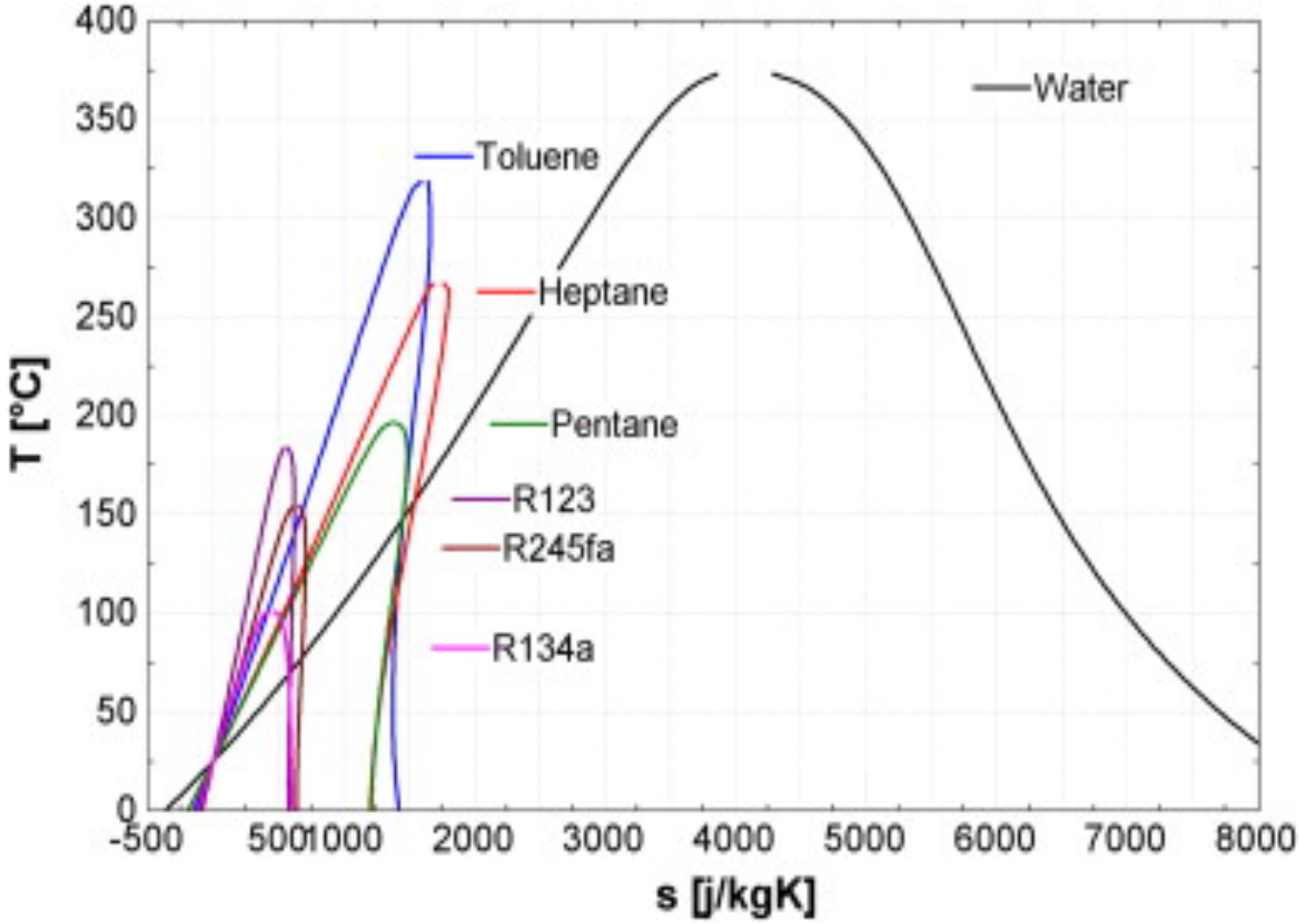
Water doesn’t only have advantages for these applications. For example :

- With water, the necessity to have a hot source over 400°C to get an efficient cycle economically profitable.
- An operation with pressure over 40 bars that involves permanent surveillance of the installation.
- The necessity to implement auxiliaries such demineralization systems. But it’s expensive.
- The difficulty to find reliable manufacturers for small scale installations
- The important wear of the turbine due to liquid water at the end of the expansion phase.

Water : wetting agent

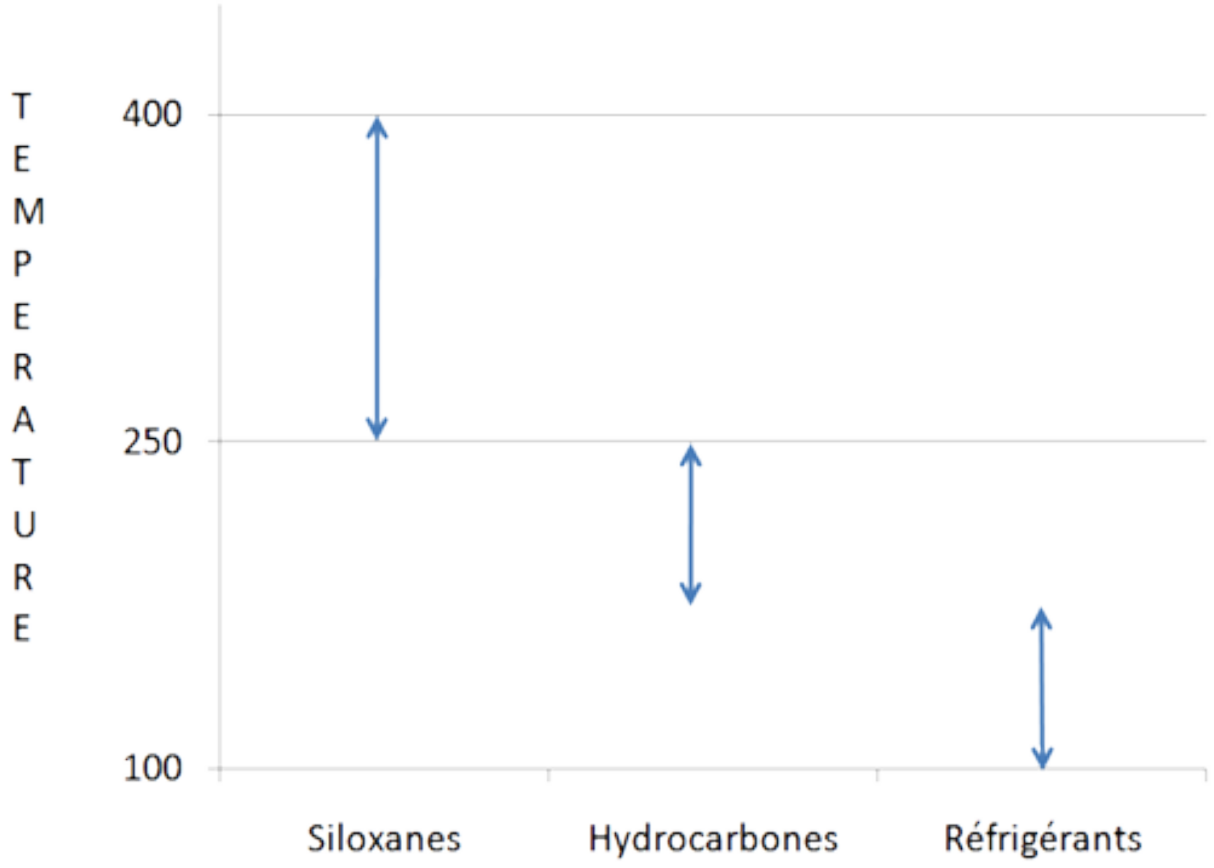
Organic fluids : dry fluids





There is 2 differences !

Lots of usable fluids



HOW the ORC works ?

Lets talk about efficiency !!

Energy efficiency of a cycle is :

$$\frac{\text{energy quantity recovered by the final user}}{\text{primary energy needed to run the machine}}$$

The yield of a cycle is :

$$\frac{\text{what the machine actually produces}}{\text{what it could produce in the ideal case}}$$

The efficiency of such a cycle equals :

$$efficiency = 1 - \frac{Tf}{Tc}$$

Tf in °K
Tc in °K

The differences between ORCs and steam cycles :

- Superheating
- Low temperature heat recovery.
- Pump consumption.
- High pressure
- Fluid characteristics.
- Efficiency.

Advantages of the ORC	Advantages of the steam cycle
No superheating	Higher efficiency
Lower turbine inlet temperature	Low-cost working fluid
Compactness (higher fluid density)	Environmental-friendly working fluid
Lower evaporating pressure	Non-flammable, non-toxic working fluid
Higher condensing pressure	Low pump consumption
No water-treatment system and deareator	High chemical-stability working fluid
Turbine design	
Low temperature heat recovery, once-through boiler	

Conclusion

The number of references and installed power is continuously growing for more than 20 years. We even observe an increase of the number of projects since the beginning of the 2000s.

The figure on the right is a comparaison about the different module which are in common with the ORC system.
So, you can see what Solar applications are uncommon!