

ORCmKit :

An open-source library for organic Rankine cycles modelling and analysis

by

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Presentation outline

- Context
- Goal of ORCmKit
- Simulation environment
- Models description
- Additional features of ORCmKit
- Conclusion

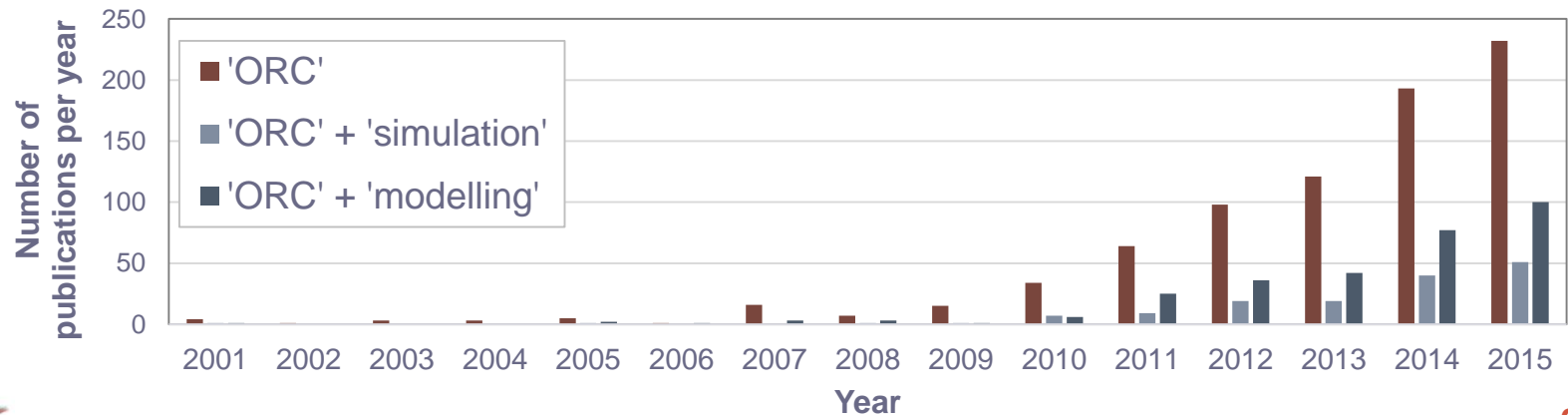
Context

ORC = Rankine cycle + organic working fluid



Thermal engine for low-grade temperature/ small-capacity applications:

- Rising interest in ORC systems over a decade
- Simulation tools are crucial and unavoidable (sizing, control, etc.)
- Commercial tools exist but are very expensive (up to 10.000\$/year)
- Self model development is time consuming



Goal of ORCmKit

ORCmKit: open-source modelling repository



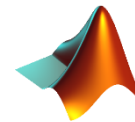
- Aimed to provide, at a single place, open-source, reliable and robust models for the **steady-state simulation of ORC systems** and their components
- Initiated by the authors but aimed to be actively updated and improved by researchers in the field
- Very diversified: large variety of modelling approaches, different modelling environments, component an cycle models, different system architecture, etc.

Simulation environment

Currently, three modelling environments covered by ORCmKit:



EES



Matlab



Python

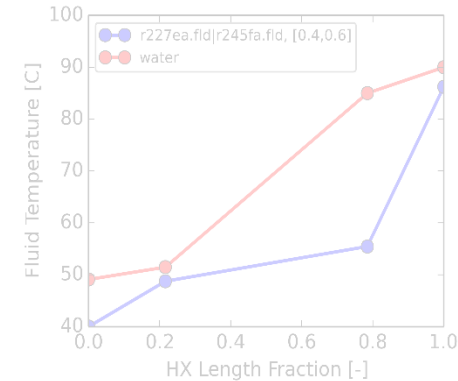
Distribution	Non-free	Non-free	Open-access
Causality	Acausal	Causal	Causal
Thermophysical library	<ul style="list-style-type: none"> • EES library • CoolProp • REFPROP • user-implemented • etc. 	<ul style="list-style-type: none"> • CoolProp • REFPROP • user-implemented • etc. 	<ul style="list-style-type: none"> • CoolProp • REFPROP • user-implemented • etc.
Model development	Fast	Slow if complex implicit model	Slow if complex implicit model
Model flexibility	High	Low	Medium (causal but object-oriented modelling)
Model robustness	Low for complex systems	High if properly implemented	High if properly implemented
Cascaded tasks	Not user-friendly	User-friendly	User-friendly

Models description

- Component-level models

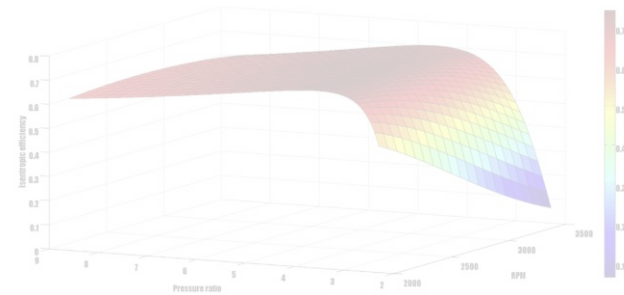
Heat Exchangers:

- Pinch-based model
- Efficiency-based model
- Moving- boundary models



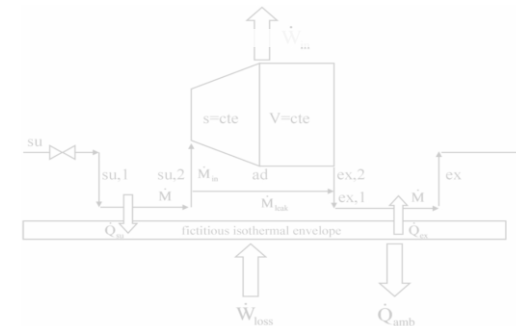
Pump/Expander:

- Efficiency-based model
 - Constant values
 - Polynomial regressions
 - Empirical correlation (Pacejka, etc.)
- Semi-empirical model



Pipelines

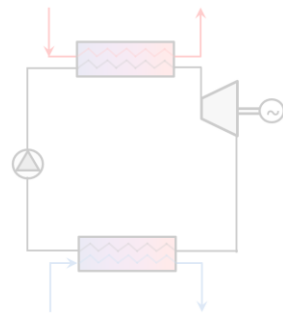
- Pressure drops
- Ambient losses



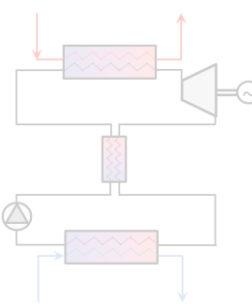
Models description

- Cycle-level models

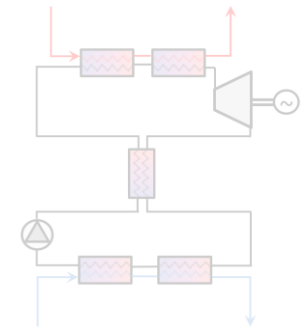
→ Multiple system architecture



Basic ORC

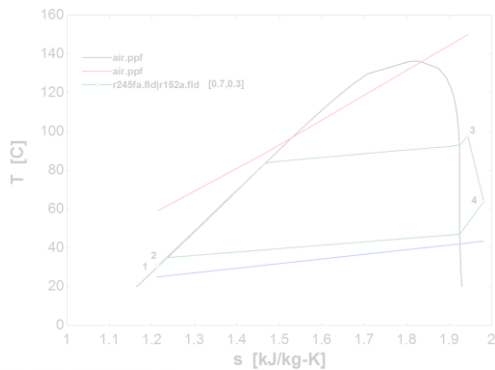


Recuperative ORC

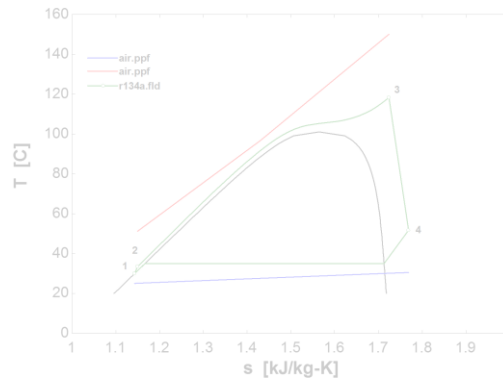


Multiple HEX ORC

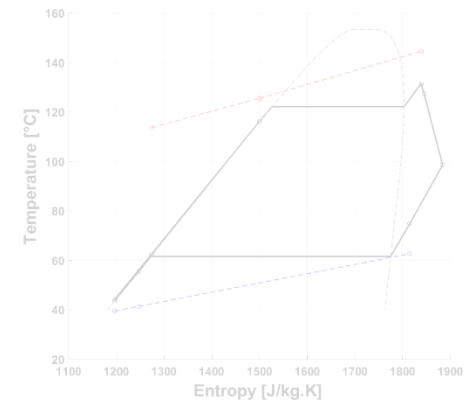
→ Multiple operating conditions



Zeotropic mixture



Transcritical ORC



Recuperative ORC with 5 HEX **7**

Models description

- Cycle-level models (example)

- Off-design performance simulation

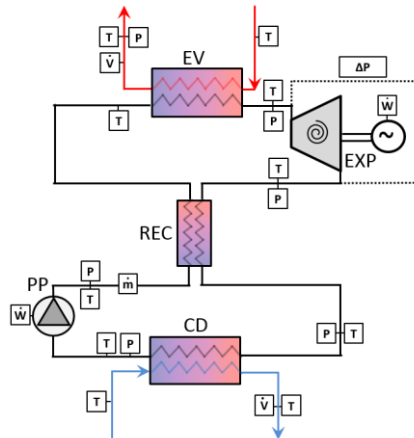
- Model inputs:

- $\dot{m}_{htf}, T_{htf,su}, P_{htf,su}$
- $\dot{m}_{ctf}, T_{ctf,su}, P_{ctf,su}$
- N_{exp}, N_{pp}, M_{ref} (or ΔT_{sc})

- Model outputs:

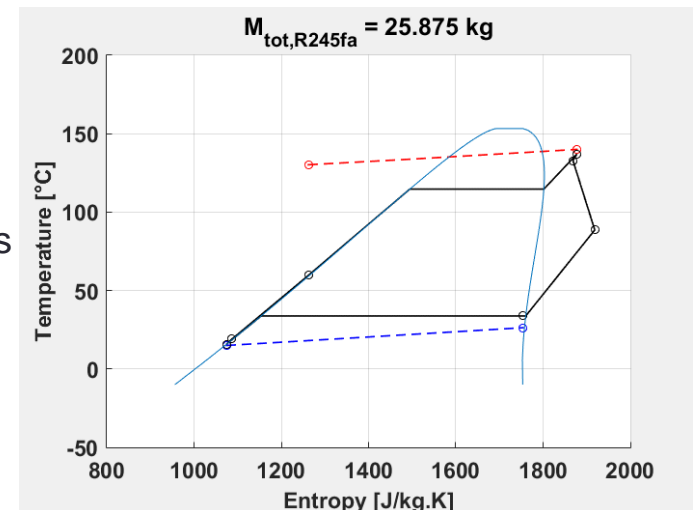
- $T_{i,cycle}, P_{i,cycle}, S_{i,cycle}$
- $Q_{i,hex}, W_{mec}$
- ϵ_{ORC}

↳ Charge sensitive!



Example: Sun2Power ORC

Effect of the refrigerant mass on the off-design cycle performance



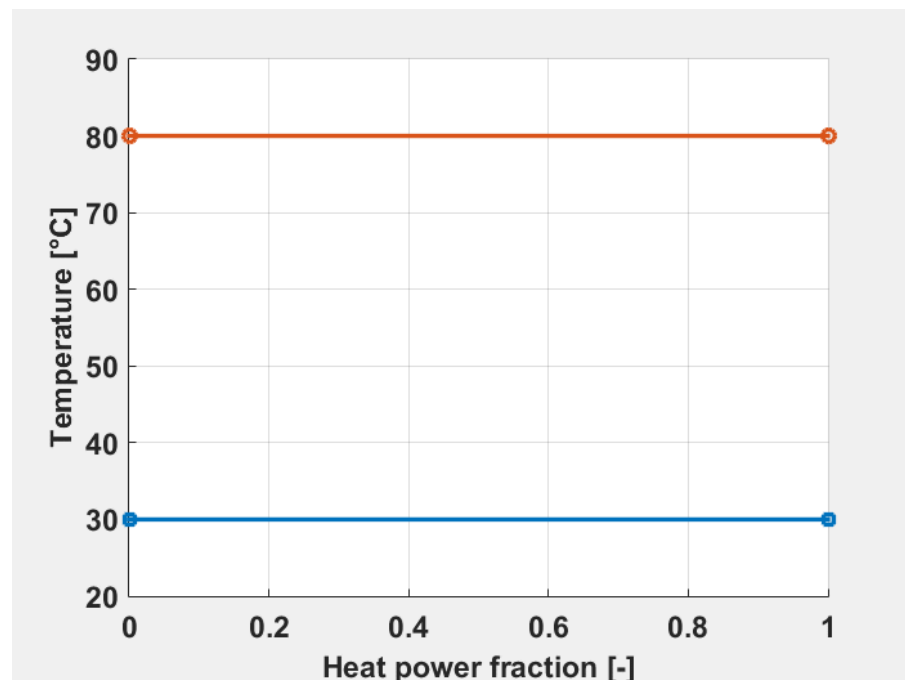
Additional features of ORCmKit

Additionally to the model source codes, ORCmKit includes other useful features, for example:

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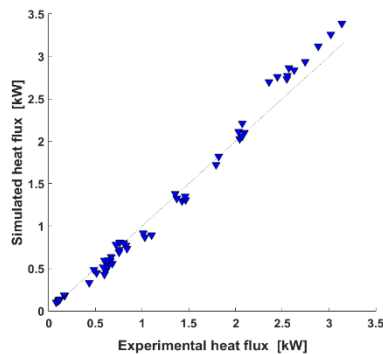
- Convenient pre-implemented graphical tools (Ts diagram, temperature profiles in the heat exchangers, etc.)



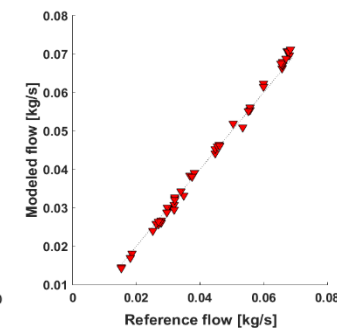
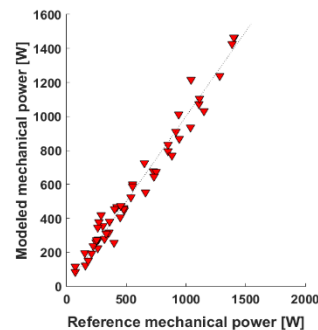
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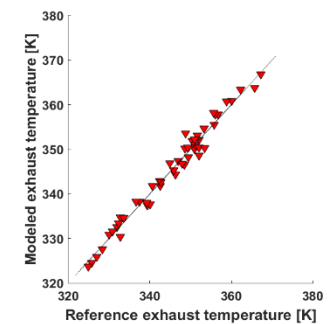
- Convenient pre-implemented graphical tools (Ts diagram, temperature profiles in the heat exchangers, etc.)
- Calibration codes to tune the different models parameters based on user-provided data



Evaporator model



Expander model



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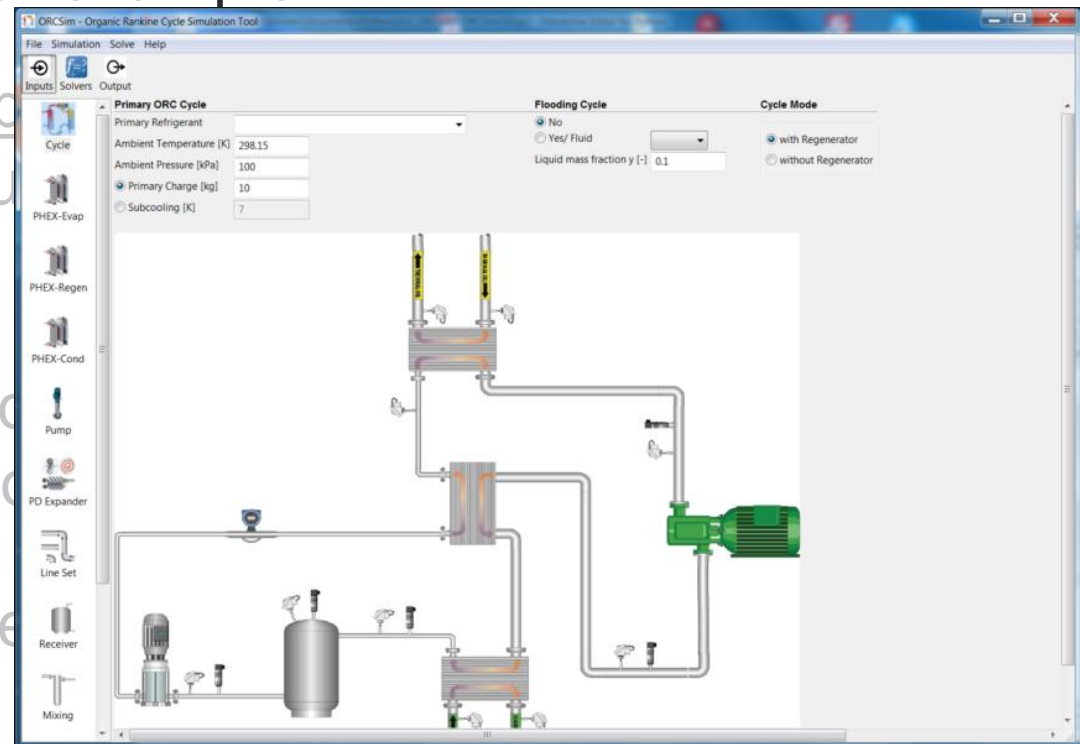
Additionally to the model source codes, ORCmKit includes other useful features, for example:

- Convenient pre-implemented graphical tools (Ts diagram, temperature profiles in the heat exchangers, etc.)
- Calibration codes to tune the different models parameters based on user-provided data
- A documentation describing the different models and codes

Additional features of ORCmKit

Additionally to the model source codes, ORCmKit includes other useful features, for example:

- Convenient pre-imp diagram, temperature etc.)
- Calibration codes to parameters based codes
- A documentation de codes
- A user-friendly GUI (for the Python-based models)



Link to ORCmKit and conclusion

Find ORCmKit:

- on GitHub

→ <https://github.com/orcmkit/ORCmKit>

- through the KCORC website:

→ <http://www.kcorc.org/en/open-source-software/>



**We want YOU
for ORCmKit !**

Thanks for your attention

Any questions?

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