

Study and development of evaporators for residential-scale cogeneration systems based on organic *Rankine* cycles

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Central research interests: sustainable, efficient and low carbon energy systems; micro & mini - cogeneration systems, Rankine technology; combustion systems and heat transfer analysis.

Micro-cogeneration (μ -CHP):

- Residential sector has the highest share;
- Excellent potential in terms of energy and GHG-emissions savings (Table 1).

Organic Rankine Cycle (ORC):

- The simpler and less likely to raise difficulties to retrofit the conventional systems;
- The big share of the main ORC components are studied and available (Fig. 1).

Research questions:

- What are preventing the market breakthrough of ORC based micro-CHP systems?
- What design principles should be followed to develop a suitable evaporator for micro-CHP systems based on ORC technology?
- Is the known risk of thermal degradation of the organic fluid a real barrier to the development of direct vaporization evaporators? (Fig. 4)

Fig. 3: 2D view of the evaporator section with the gas and organic fluid control volumes.

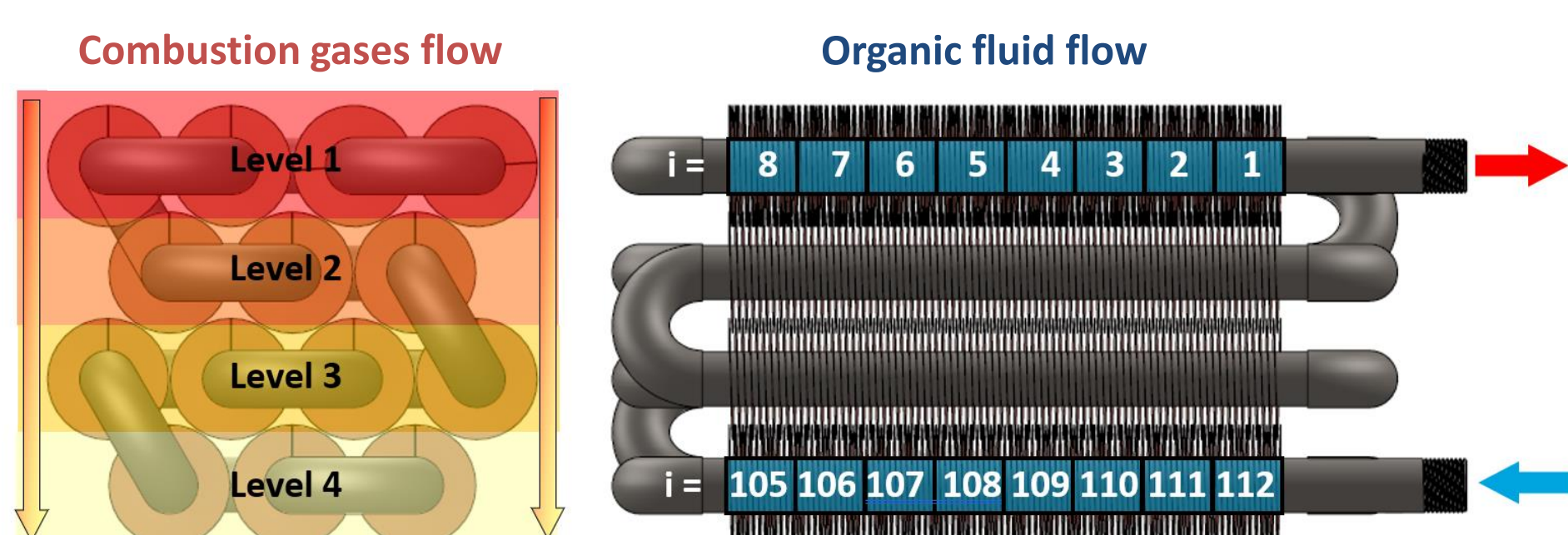


Table 1: Micro-CHP expected sales, potential primary energy savings and GHG emission reductions for the residential and SME/collective sector in Europe.

Residential systems (± 1 kWe)*	SME & Collective systems (± 40 kWe)**
Expected sales: in 2020: 52 000 units/year; in 2030: 2 900 000 units/year;	Expected sales: in 2020: 2 700 units/year; in 2030: 68 000 units/year;
Potential primary energy savings in 2030:	
300 000 TJ*** /year;	240 000 TJ*** /year;
Potential GHG-emissions reduction in 2030:	
13 MtCO _{2,eq} *** /year;	14 MtCO _{2,eq} *** /year;

* by replacement technology; ** by add-on technology; *** TJ Tera Joule; MtCO_{2,eq} Mega tonne of CO₂ equivalent;

Fig. 1: Schematics of the main components of an ORC based micro-CHP system.

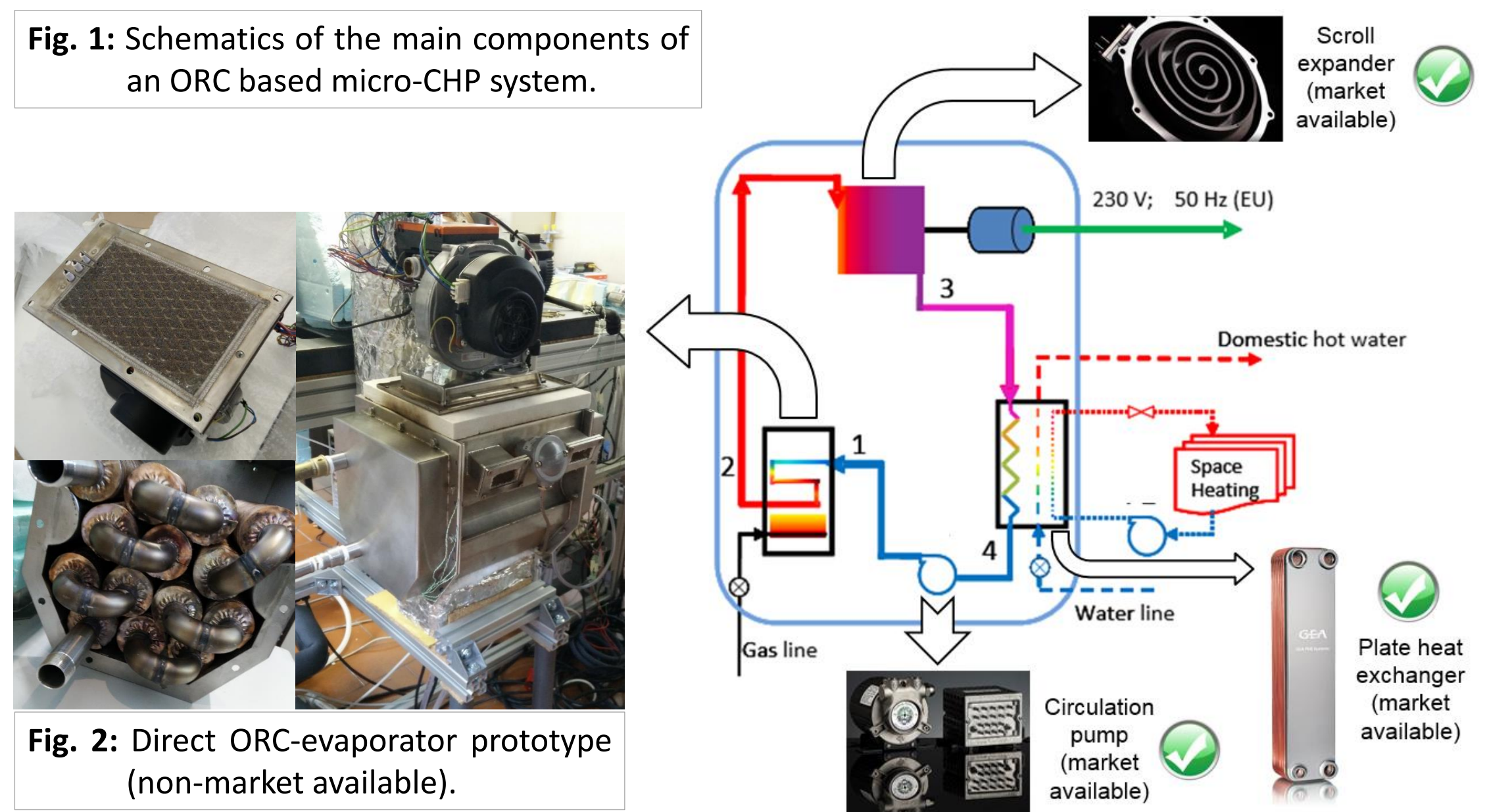


Fig. 4: Combustion gases, organic fluid (bulk and thermal degradation limit) and tubes internal and external wall temperatures along the evaporator.

