Transient Analysis of Optical Efficiency: Fast Qualification of Line Focus Collectors in Large Power Plants

Desired information

- **Ideally**: optical efficiency values of each collector
  (may include e.g. optical peak efficiency, incidence angle modifier IAM or cleanliness)
- **Realistically**: relative optical performance of each collector/loop (due to lack of mass flow sensors and/or accurate measurements, depending on solar field setup)
- **Challenge**: steady-state conditions do not exist in a large power plant

Relevant for

- **Commissioning**
  (correct collector alignment)
- **Maintenance**
  (soiling/degradation in loop)
- **Operation**
  (current status, e.g. for control)
- **Acceptance Testing**
  (same methodology and model, but different sensor set-up) [1]

Key advantages of new method

- The model makes the difference: discretised, multi-node, transient model of collector
- Thermal capacity in model instead of being an estimated [1] parameter
- Very short evaluation periods

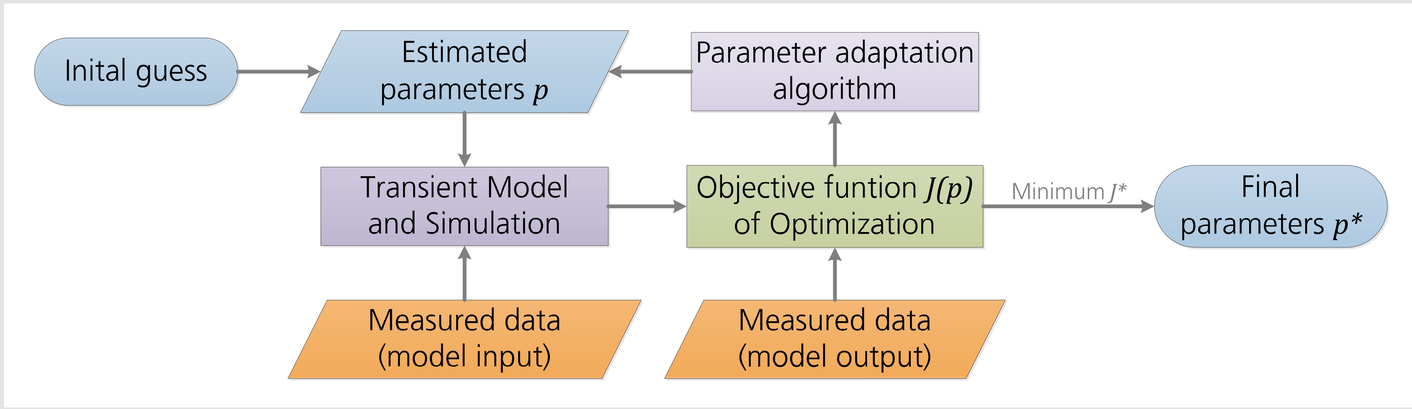
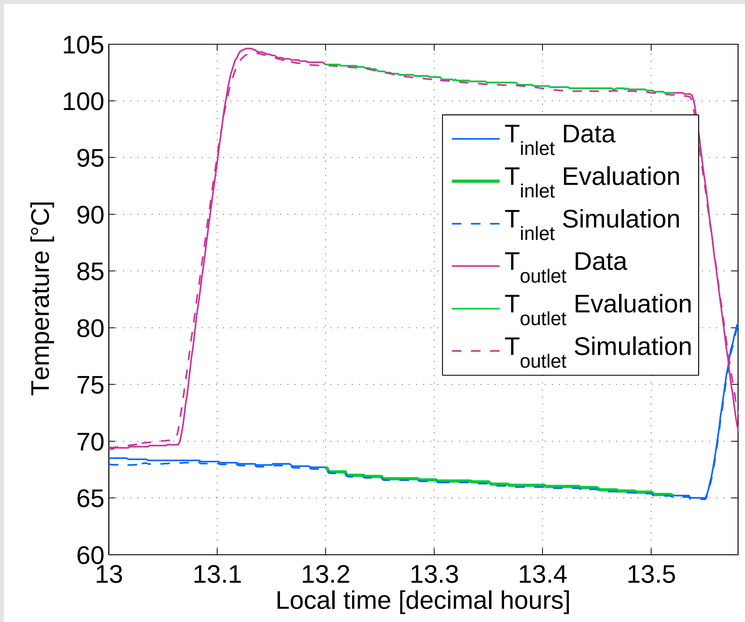


Fig. 1: Methodology for optical efficiency estimation by transient modeling and optimization.



Example:
Determination of optical efficiency

Short focus of collector, with decreasing inlet temperature

Steady-state result: 75.1 %

New transient method: 73.7 %

→ Systematic error compensated!

Fig. 2: Data and simulation for assessment of optical collector efficiency with liquid water at DISS test facility at Plataforma Solar de Almería, Spain; test on June 19, 2013; discretized model by DLR.

→ Advanced testing procedure for fast DSG loop assessment: collector-wise focus starting from loop outlet to inlet with time shift

→ Optical efficiency of evaporation field with 6 collectors per loop (Fig. 3 b) may be completely assessed in less than 3 hours

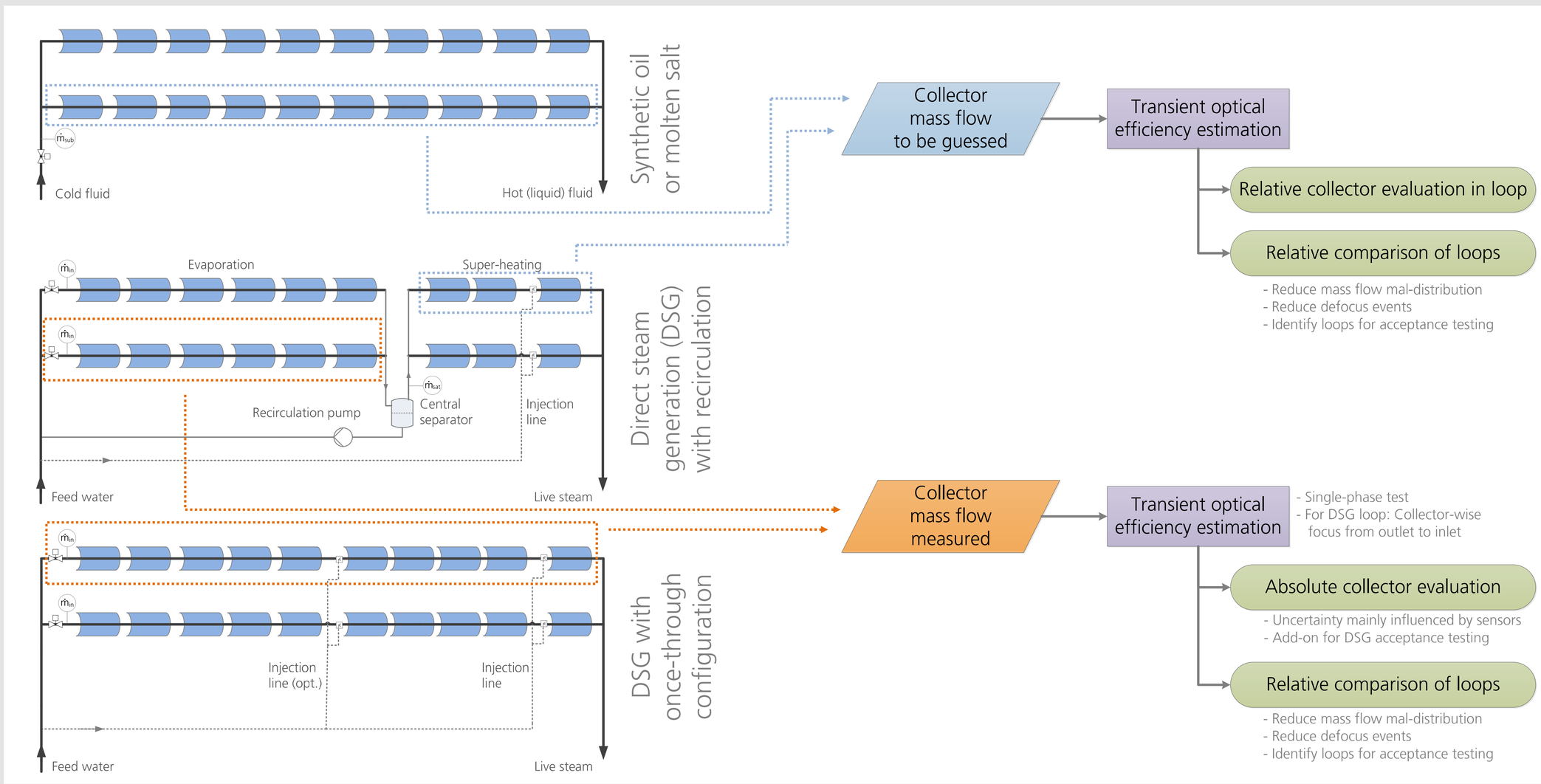


Fig. 3: Solar field layouts of power plants with line focus systems and corresponding application of methodology by operational data (single-phase flow) or by advanced collector-wise focus procedure (single-phase in evaporation collectors/loops)

[1] Janotte, N., Hofer, A. et al.: Best Practice Guideline: Dynamic in situ Performance and Acceptance Testing of Line-Concentrating Collectors and Solar Fields. Draft Version (July 2015).

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