COMET
Competence Centers for Excellent Technologies

newheat
fournisseur de chaleur renouvelable

BEST
Bioenergy and Sustainable Technologies

Optimizing Solar Preheating Applications by a Practically-applicable, Multi-domain Algorithm

Viktor Unterberger[1]
Uwe Poms[1]
Thomas Colin de Verdière[2]
Alexis Gonelle[2]
Pierre Delmas[2]
Markus Gölles[1]

Area of Automation & Control

Motivation

How to choose the optimal temperature setpoint?

In the context of SHIP (solar heat for industrial processes) installations, solar preheating applications are becoming increasingly popular for reducing fuel consumption and consequently the carbon dioxide emissions. Since the temperature is later raised to the needed process temperature, the setpoint of the solar thermal plant can be chosen more freely. This raises the question about the best value for this setpoint, taking into account both thermal and hydraulic as well as electrical and monetary concerns.

Solution

An algorithm which automatically adapts the temperature setpoint

The general structure of the algorithm consists of four different layers as shown in *Figure 1*. Within these layers the thermal, hydraulic, electric and monetary domains are considered by using mathematical models to find the overall optimal temperature setpoint for the current operating conditions (inlet temperature T_{in}, solar radiation I_g and ambient temperature T_{amb}).

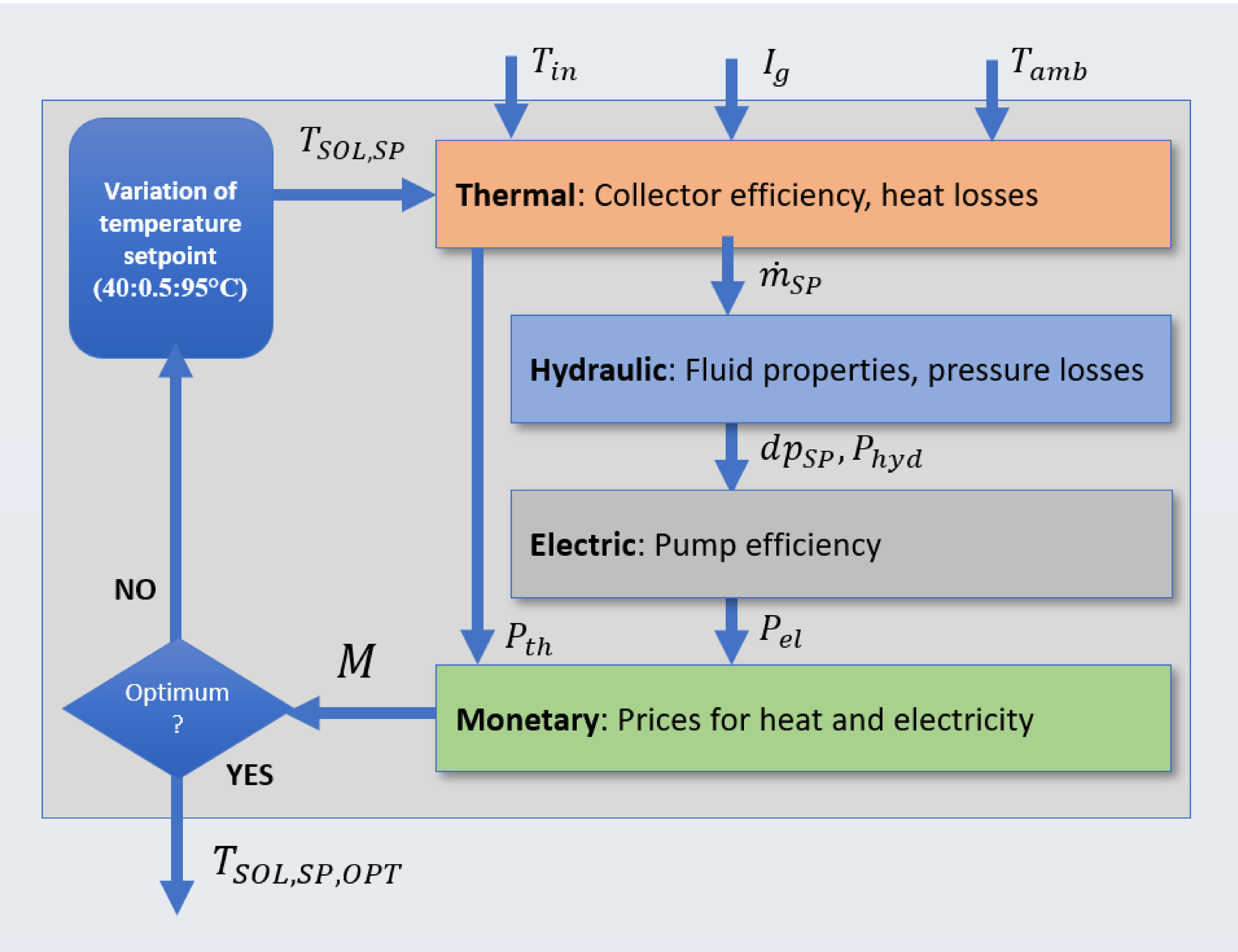

Figure 1: Schematic overview of the algorithm, its different layers, in- and outputs.

When applying the algorithm, first a temperature setpoint $T_{SOL,SP}$ is selected and then the layers are processed in the following order:

Thermal → Hydraulic → Electric → Monetary

This procedure is carried out for different setpoints for the solar feed temperature $T_{SOL,SP}$ to find the most profitable one for operating the solar thermal plant. The algorithm is carried out continuously throughout the day (e.g., every 15 minutes) to adapt to the current operating conditions.

Results

Efficiency improved by 5-10%

The algorithm was tested using a simulation model of the solar primary loop based on two coupled partial differential equations for the fluid and the collector's metal mass.

The results for a sunny day are shown in *Figure 2*, comparing the outputs of the controller (OPT') with a constant setpoint of 90°C. The first graph shows the temperatures, while the second graph shows the solar radiation for that day as well as the resulting mass flow necessary to achieve the desired temperature.

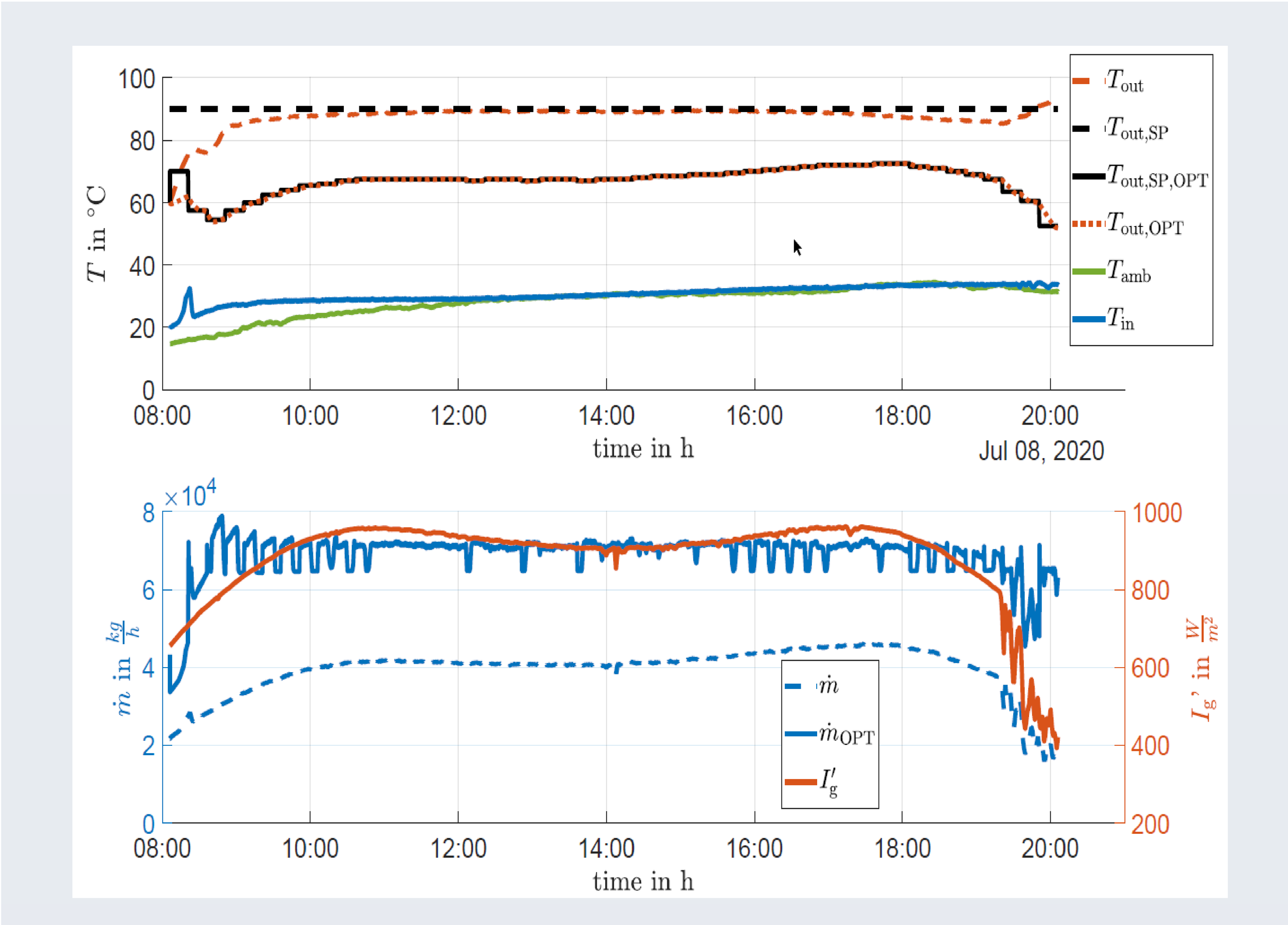

Figure 2: Simulation results when using the developed algorithm for a day with high solar radiation. The optimal setpoint is calculated every 15 min.

The optimal setpoint $T_{out,SP,OPT}$ is adapted based on the solar radiation and increases with the inlet temperature, which also leads to a higher necessary mass flow as seen in the second graph.

Based on the prices for heat and electricity existing for the investigated plant the monetary improvement is calculated to be 6.6%.

Highlights

- **optimizing** the operation of **solar preheating application**
- **optimal temperature setpoint determination** by considering multiple domains (thermal, hydraulic, electrical and monetary)
- **easily implemented** on conventional controllers
- **efficiency increase** by **5-10%**

[1] **BEST – Bioenergy and Sustainable Technologies GmbH**

Head Office Graz
Inffeldgasse 21b
A 8010 Graz

P +43 5 02378-9201
office@best-research.eu
www.best-research.eu

[2] **newHeat SAS**

185 boulevard du Maréchal Leclerc
F 33000 Bordeaux

contact@newheat.com
https://newheat.com/en/

Acknowledgements: The research leading to these results has received funding from BMK, BMDW and the Federal States Vienna, Lower Austria and Styria within the scope of the Austrian COMET - Competence Centers for Excellent Technologies Programme under the Grant Agreement no 869341. The COMET Programme is managed by the Austrian Research Promotion Agency (FFG).

FFG Promoting Innovation.
Federal Ministry Republic of Austria Labour and Economy
Federal Ministry Republic of Austria Climate Action, Environment, Energy, Mobility, Innovation and Technology
wirtschafts agentur wien
Für die Stadt Wien
Niederösterreich
Das Land Steiermark → Wirtschaft, Tourismus, Regionen, Wissenschaft und Forschung
SFG NEUES DENKEN. NEUES FÖRDERN.