Advanced Control of the Generated Steam in a Municipal Waste Incineration Plant

Helmut Niederwieser [1, 2]
Florian Jäger [3]
Friedrich Kirnbauer [3]
Markus Gölles [1, 2]

Area 2.2 Automation and Control

Highlights

- Advanced process control based on an **estimator for the flue gas mass flow**.
- Faster reaction to **varying fuel properties**.
- **Decoupling** of the steam mass flow control from the steam temperature control.
- **Increased flexibility** due to additional feedforward control.
- Support of a **stable and constant operation** of the plant to reduce thermal stress, prevent failures and keep efficiency high.

Introduction

In modern waste management, the energetic utilization of waste is an important key technology. On the one hand, it allows the waste to be disposed of in an environmentally friendly manner and, on the other hand, makes it possible to **reduce the use of other controversial energy sources**, such as nuclear fission or fossil fuels. However, the efficient and clean incineration of waste is a challenging task due to the **strong inhomogeneity of the waste**.

The considered plant is a **fluidized bed incinerator** for the incineration of **waste and sewage sludge** with a nominal capacity of **38.2 MW_{th}**. The product of the process is superheated steam at 354°C and 54 bar, which is subsequently used to generate electrical energy and also feeds the local district heating network.

Motivation for a new control scheme

The old control for the mass flow of generated steam consists of a standard PI-controller converting the control error into a speed of the waste feeder. This control strategy suffers from the following drawbacks:

1. Slow reaction to varying fuel properties due to **large dead times and time constants** in the process.
2. Strong **coupling** with the steam temperature controller.
3. Slow control behavior during **load changes**.

Advanced control using a suitable estimators

A **cascaded controller** with the overall thermal output of the flue gas as intermediate quantity reduces the effective dead times and relaxes the couplings with the temperature control. The thermal output is estimated from available measurement data using suitable mathematical models. Additionally, a **feedforward controller** improves the control performance during load changes.

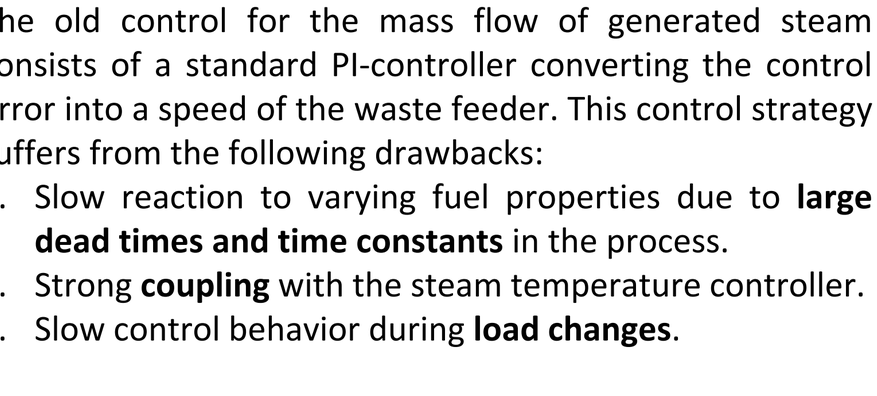

Fig. 1: Block diagram of the new control scheme.

Experimental validation

For a fair comparison of the old and the new control scheme, operation of the plant at nominal capacity without additional combustion of sewage sludge is considered. Compared to the old control, the new control **reaches the setpoint on average** and **reduces the standard deviation of the error by 23**% (Fig. 2), which is also confirmed by **statics of seven representative days** (Fig. 3).

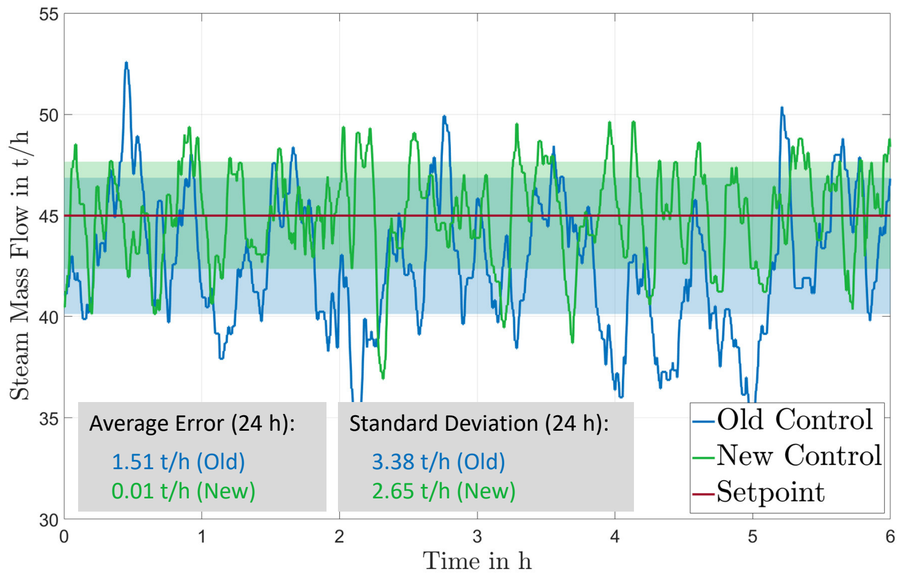

Fig. 2: Comparison of the control performances. The bands indicate the average value ± one standard deviation.

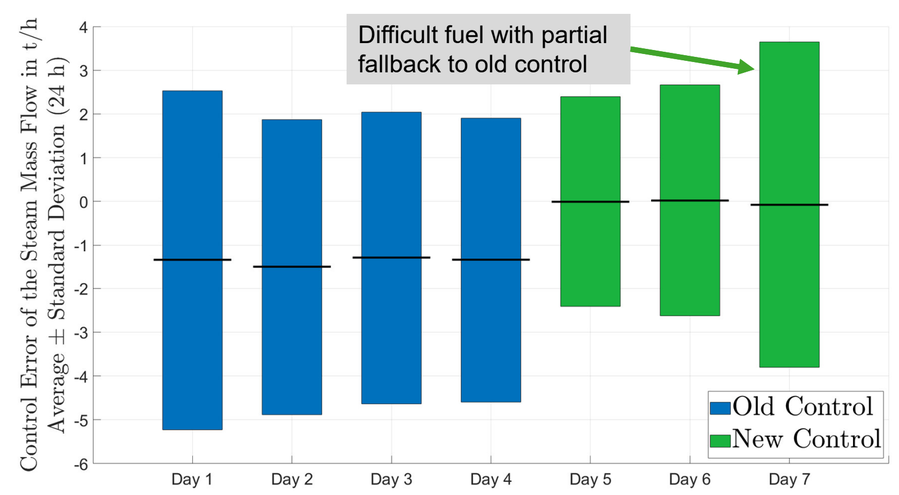

Fig. 3: Statistics of the control error.

The temperature fluctuations in the reactor head are used to evaluate the thermal stress on the plant (Fig. 4). The new control scheme yields a significant **reduction of the standard deviation** of these fluctuations **by 34%**.

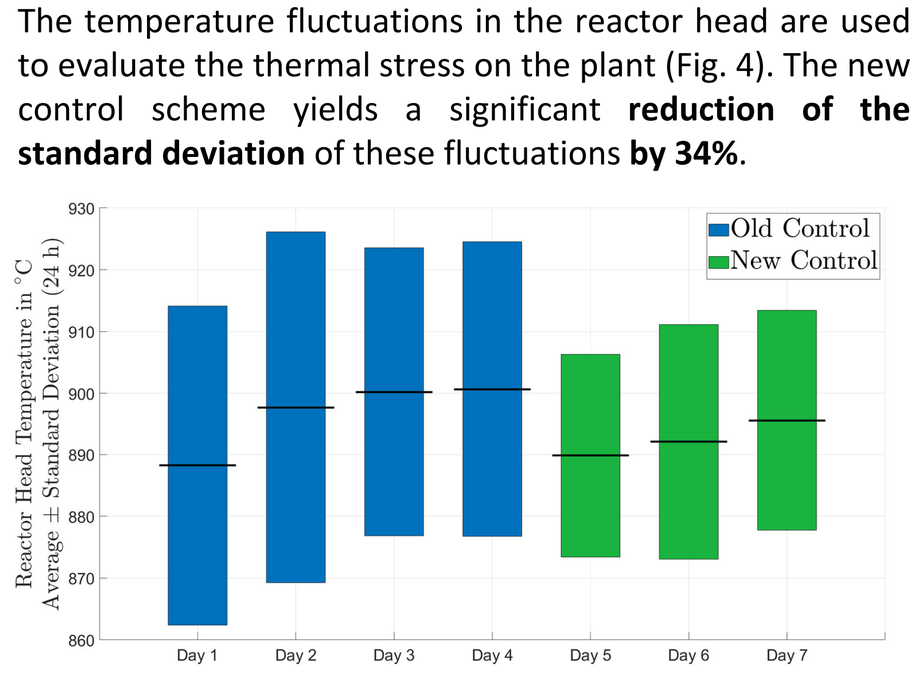

Fig. 4: Statistics of the reactor head temperature.

Conclusion

With the new control scheme, the **setpoint of the steam mass flow is reached on average** and the **fluctuations are noticeably reduced**. The **thermal stress** of the plant is diminished. Thus, a **stable and constant operation** of the overall plant is supported.

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

[1] BEST - Bioenergy and Sustainable Technologies GmbH, [2] Institute for Automation and Control, Graz University of Technology, Graz, Austria, [3] Wien Energie GmbH, Vienna, Austria

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