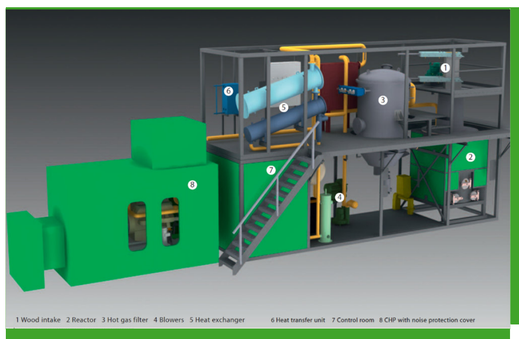

Increased flexibility of a fixed-bed biomass gasifier through advanced control

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Area 2.2 Automation and Control

Highlights

- Advanced **model-based control strategy** used for an industrial fixed-bed biomass gasifier
- **Experimentally verified** on an industrial plant
- **Increased flexibility** of the gasifier at **part load operation without manual interactions**
- Easy **applicability** for similar fixed-bed gasifiers

Fixed-bed biomass gasifier and its control strategy for char handling

The industrial fixed-bed biomass gasifier typically operates at **nominal load** (**300 kW_{th}** and **150 kW_{el}**). During the gasification process, char accumulates on a grate located at the bottom of the gasifier until this grate rotates, causing the char bed to partly deflate and char particles to be disposed. The **state-of-the art grate control** uses the **pressure downstream** the gasifier as an indicator for the height of the char bed to trigger a new grate rotation u_{gr} whenever the measurable pressure difference Δp_{fbg} over the gasifier exceeds an empirical threshold Δp_{fbg}^{*}. In contrast, the **new grate controller** operates based on a recursively estimated **flow resistance** of the gasifier R_{fbg} with another threshold R_{fbg}^{*} (Fig. 1).

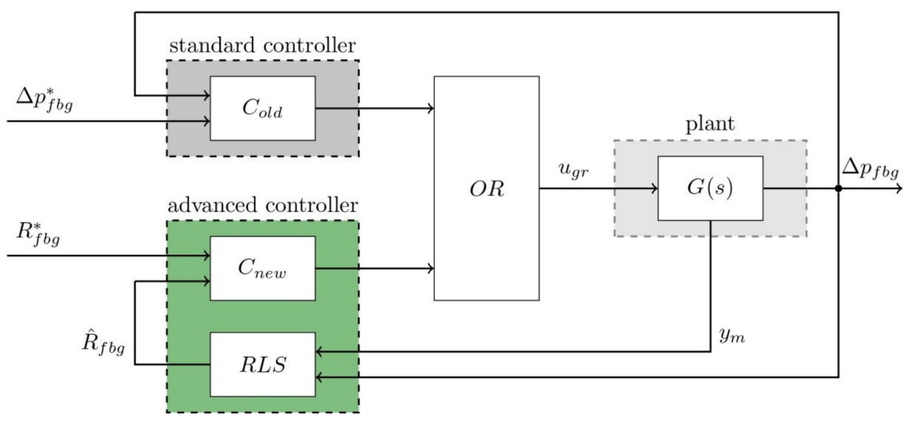

Fig. 1: Block diagram of the control strategy for the grate

Why a new advanced control strategy?

The **state-of-the art control strategy** is designed for steady-state operation at **nominal load only**. At the current state, flexible operation requires a plant operator to **manually adjust** the control parameters for part load operation. Because it uses **pressure as indicator** for the char bed height, which is only valid if entering and exiting material flows remain constant.

In **part load operation** the grate rotates less frequent than required. In particular, long pauses between two consecutive grate rotations allow **the char bed to grow unintentionally**, which affects the temperature and pressure distribution inside.

To increase **flexibility** and **stable operation** at part load, a more suitable process parameter like the **flow resistance** describing the internal state of the gasifier is needed. This flow resistance depends only on the properties of the char bed but not directly on the mass flow rate of the gas passing through the char bed.

Results: experimental verification

Comparison of the state-of-the art and the new grate controller at part load (135 kW_{el})

Exemplary change of the control strategy.

The **new grate controller stabilizes** the **flow resistance** of the gasifier (Fig. 2) at the threshold by **rotating the grate more frequently** and **evenly** than the standard controller (Fig. 3). This leads to a **more homogeneous gasification** and reduces the undesired significant fluctuations in the flow resistance and the gas temperature (Fig. 4) caused by an unintentional accumulation of the char bed. The new controller **stabilizes the temperature**.

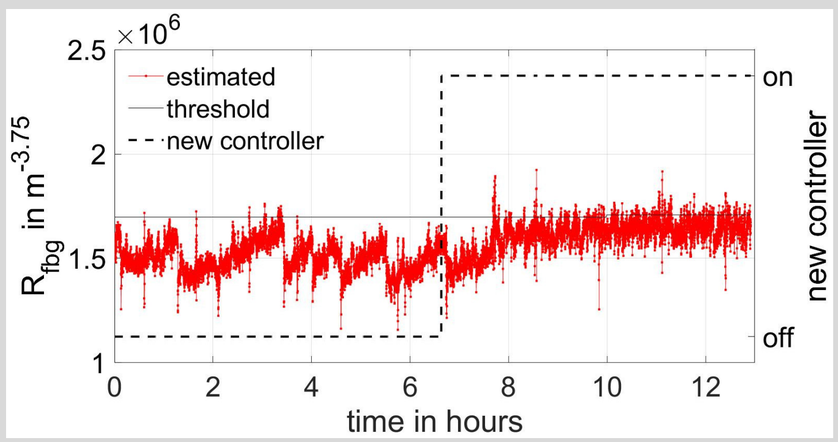

Fig. 2: Flow resistance of the fixed-bed gasifier

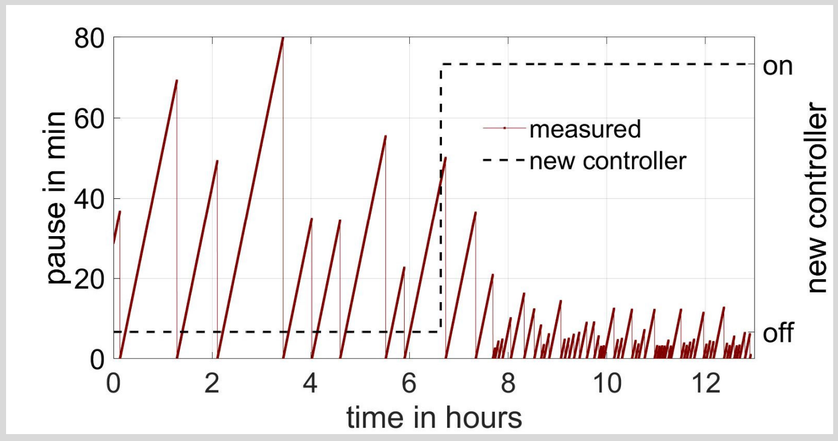

Fig. 3: Time between two consecutive grate rotations

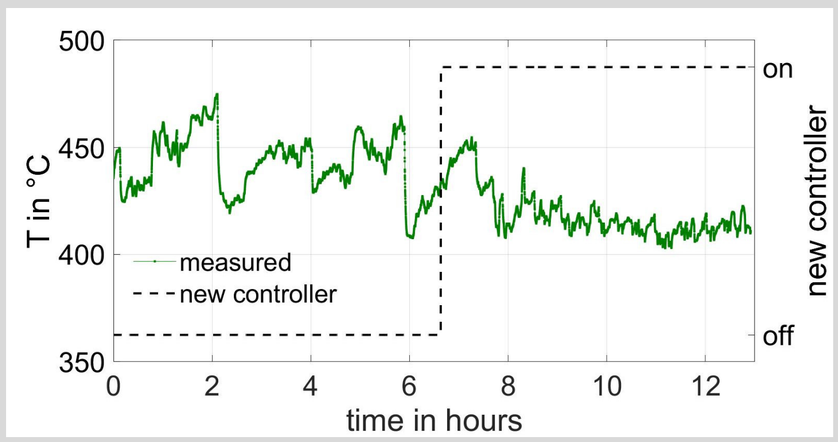

Fig. 4: Temperature of the gas exiting the gasifier

Conclusion and outlook

The **new grate controller** allows a **flexible operation without any manual interaction** of the plant operator. The new controller rotates the grate that **homogeneous gasification** is reached both **at part** and **nominal load operation**.

The new controller can be applied to similar plants, because it is **easy adaptable** and **does not need any reconstruction.**

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