Public Abstract
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Title:MU-SYNTHESIS CONTROLLER DESIGN FOR TEMPERATURE CONTROL OF A SOLAR STEAM GASIFIER WITH UNCERTAINTY MODELING AND ROBUST ANALYSIS

Gasifiers operate by inputting a carbon rich material, water, and heat into a reactor core to cause a chemical reaction to produce a desired chemical composition output. For this work, a unique hybrid allothermal/autothermal solar steam gasification process was utilized to produce synthesis gas by inputting lignite, water, and solar irradiation. Oxygen is also fed into the reactor to burn off a portion of the lignite if the solar irradiation is not sufficient to fuel the reactor. The gasifier is set to operate at a specific temperature to keep the total amount of syngas produced at a precise value. Since solar irradiation fluctuations would cause temperature fluctuations, temperature regulation via controlling the amount of lignite and oxygen fed into the reactor core was implemented. Two different controller synthesis methods were used: µ-synthesis with D-K iteration and Ziegler-Nichols to tune a PID controller. Both controllers maintain reactor temperature at or above a specified set point by equally varying the amount of lignite and oxygen fed into the reactor core. A high fidelity model developed in previous work was utilized to create a linear, time-invariant model for controller synthesis. Multiplicative uncertainty was used to create an uncertainty model to quantify and account for the dissimilarities between the high fidelity model and the linear model. Performance specifications on temperature error and maximum control effort were chosen to guarantee fast response of the controller as well as reliable temperature control. Five day simulations using meteorological data to estimate solar irradiation were ran for both controllers and then compared. Simulations gave more insight into the range of operation for the high fidelity model. The linear and uncertainty model was refined to better represent the high fidelity model. The controllers were compared on three different criteria: temperature control, total syngas production, and cold gas ratio. The µ-synthesis controller performed better than the PID controller for temperature control. For total syngas production and cold gas ratio, the controllers performed equally. The µ-synthesis controller was also found to have better robust properties than the PID controller.