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WASTE-HEAT RENEWABLE GASIFIER DESIGN THROUGH TAGUCHI'S METHOD AND MANFIS

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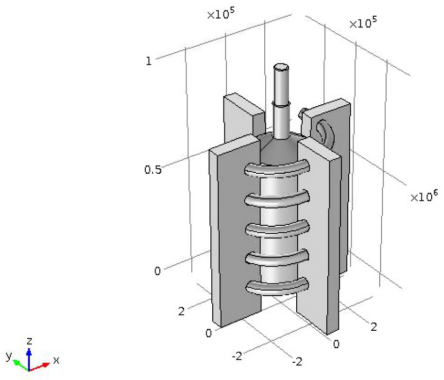
Abstract – Ensuring a global average temperature increase of no more than 1.5 °C is crucial for aligning with the objectives of the Paris Agreement. The Intergovernmental Panel on Climate Change (IPCC) estimates that a 45 % reduction in carbon dioxide emissions by 2030 or a 25 % reduction by the same year is necessary to cap the temperature rise at 2 °C. Failure to achieve this target by 2030 would necessitate substantial subsequent reductions to compensate for the delayed progress toward net zero emissions, potentially incurring higher costs. Elevating the focus on enhancing energy efficiency has emerged as a key strategy in expediting progress toward these climate goals. Hydrogen, renowned for its high efficiency and emission-free combustion, is anticipated to play a pivotal role in this endeavor. Traditionally, gasifiers have served as the conduit for transforming inexpensive fuels like coal or biomass into hydrogen. However, their energy-intensive nature poses a challenge. Addressing this inherent issue, an innovative approach known as the external-heating gasifier has been proposed and designed. The design of the external-heating gasifier represents a quintessential nonlinear and multiple-input multiple-output (MIMO) problem. To achieve optimal performance, the integration of Taguchi's method and inverse-model technology has been employed with a simulation platform developed using the COMSOL Multiphysics software. Initially, Taguchi's method was utilized to determine the minimum number of experiments required for a full-factorial design and identify the most critical factors influencing product performance. Subsequently, an adaptive neuro-fuzzy inference system (ANFIS) was developed with a MIMO–ANFIS architecture. This system was employed to train an inverse model, facilitating the mapping of relationships between each input and output set. In essence, this approach enables the identification of manufacturing parameters that result in optimal performance. To illustrate the efficacy of the proposed method, a simulation study on an existing gasifier is presented.

Keywords – Waste-heat renewable gasifier; Taguchi's method; MIMO problem; MANFIS



Waste-heat renewable gasifier design.

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