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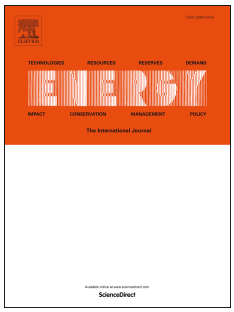

Mathematical modeling, simulation and validation of a boiler drum: Some investigations

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Mathematical Modeling, Simulation and Validation of a Boiler Drum: Some Investigations

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Abstract

The boiler or steam generator is a widely-used energy conversion equipment across the industry to generate steam for power generation or utility purposes. Recently, there is an increasing demand to operate the thermal power plant boilers in more flexible and agile manner due to renewable energy penetration, excess generation capacity, online trading, etc. Mathematical models representing dynamic behavior of the power plant boilers across wide-range operational scenarios like start-ups and load-changes are necessary for such operability and control studies. However, boiler models suitable for such investigations are scarce in the literature. This paper presents a mixed standard lumped model representing the boiler-drum dynamics and a 1-dimensional distributed model based on two-phase thermal hydraulic stability code to represent dynamics of evaporator sub-system. The model is validated using wide-range operational plant data collected from a boiler unit of a combined cycle power plant. Besides, the performance of the proposed model is compared with other two well-known first-principle based models. The performance metrics used for comparisons are small range accuracy, wide-range accuracy, relative computational time and memory requirements. The proposed model is found to out-perform existing models, particularly for the wide-range dynamic operational scenario.

Keywords: `boilers, dynamic simulation, mathematical models, nonlinear systems, steam generators`

1. Introduction

The boiler or a steam generator is an energy conversion equipment or system that transforms chemical energy of a fuel such as coal, oil, gas or nuclear energy into thermal energy and uses the heat to convert water into steam. The generated steam is used either as a utility to heat or dry certain materials and goods or to perform some mechanical work by expanding it through a heat-engine,