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An all-condition simulation model of the steam turbine system for a 600 MW generation unit

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Abstract: Coal-fired generation units in China often operate under off-design loads. The off-design performance has important influence on operation energy consumption of generation units. An all-condition model is of critical importance for studying the off-design performance. In this paper, an all-condition simulation model of the steam turbine system for a 600 MW generation unit is built. Based on the actual system composition, the steam turbine system is divided into several sub equipment. A sub model is established for each device. In the turbine model, a parameter M is defined as the intermediate variable to calculate the extraction pressure of turbine. The operating data from a 600 MW generation unit are used to verify the all-condition model. The heater fouling conditions are also calculated. The result show that the model successfully predicts the operation parameters under different loads and forecasts the thermal performance of typical equipment failure.

***Keywords*:** All-condition, simulation model, steam turbine system, turbine, heater

1. Introduction

In China, to ensure power supply, coal-fired generation units frequently operate under off-design loads [1]. With the operation of the unit, the state of the device can produce a certain degree of degradation, further deviating from the design load. As a result, the all-condition modeling and simulation of the steam turbine system has considerable significance for unit's performance analysis, optimization of operation and system design [2].

Models have been developed to predict both the steady and transient performance of a turbine. Luo et al. [3] formulated a mathematical model incorporating a rigorous turbine simulation to achieve an optimal heat integration scheme. Maraver et al. [4] proposed an optimization model of the organic Rankine cycles to predict the best cycle performance in terms of its exergy efficiency with different working fluids. Delft University of Technology developed a software named SimECS for the dynamic simulation of energy conversion systems[4],validated by comparison with measured data coming from a laboratory scale steam cycle setup.By using the SimECS,a dynamic model of a small biomass-fired power plant is developed and validated quantitatively against steadystate values obtained using a well known, reliable steady-state process modeling software[5][6]. Cui et al. [7] introduced both a phenomenological and a constitutive crack initiation lifetime estimation model for steam turbine components. Kim et al.[8] presented a model to simulate the dynamic operation of regenerative gas turbines and the transient behavior of a small engine equipped with a stationary recuperator. Korakianitis et al. [9] presented transient-flow component models for the prediction of the transient response of gas turbine cycles.

Many researchers built the power plant's simulation model by using commercial software such as Aspen Plus , Aspen Plus Dynamics and APROS(advanced process simulation software). In Ref[10]and Ref[11], a combined cycle power plant model is built using the process simulation software tools Aspen Plus Dynamics and Apros. The generated numerical models are validated against the measurements at different steady-state