With world energy consumption growing, and nonrenewable energy resources being quickly depleted, it is important to design more efficient power plants and thereby economically utilize fossil fuels. To that end, this work focuses on thermodynamic modeling of steam power systems to enhance our understanding of their dynamic and transient behavior. This thesis discusses the physical phenomena behind a heat recovery steam generator (HRSG), and develops a mathematical description of its system dynamics. The model is developed from first principles of fluid flow, phase change, heat transfer, conservation laws, and unsteady flow energy equations. The resulting phenomenological model captures coupled physical phenomena with acceptable accuracy while achieving fast, and potentially real-time simulations. The computational HRSG model is built in the Siemens T3000 platform. This work establishes the dynamic modeling capability of T3000, which has traditionally been used for programming control algorithms. The validation objective of this project is to accurately simulate the transient response of an operational steam power system. Validation of the T3000 model is carried out by comparing simulation results to start-up data from the low-pressure system of a Siemens power plant while maintaining the same inlet conditions. Simulation results are well correlated with plant data in terms of transient behavior and equilibrium conditions. With a comprehensive HRSG model available, it will allow for further research to take place, and aid in the advancement of steam power system technology. Some future research areas include extension to intermediate and high pressure system simulations, combined simulation of all three pressure stages, and continued improvement of the boiler model. In addition to enabling model-based prediction and providing further insight, this effort will also lead to controller design for improved performance.

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The public is welcome to attend.