

Boiler-Turbine Simulator with Real-Time Capability for Dispatcher Training Using LabVIEW

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Abstract—This paper presents an open loop dispatcher training simulator for boiler-turbine implemented in LabVIEW for COLTERM heating power plant of Timisoara, Romania. The system employs real-time capability, graphical user interface (GUI), uninterrupted operator interaction, having as background a low order boiler-turbine model for dynamic simulation. The operator manually controls the fuel charge on each of the three boilers, the turbine valve position and the steam to consumers, to anticipate parameter evolution on each boiler and the electric power generated by turbine.

I. INTRODUCTION

The data problems and the need for accurate low order models representing boiler dynamics is not new [1]. Every model has to be adapted in parameter and architectural terms for each cogeneration plant. These models are built by using the fundamental principles of mass, energy and volume balances. The results are complex or simplified models. Comparatively, the responses of these models can be considered as equally valid [2].

A suitable boiler model for long term dynamics simulation of a heating power plant system must accurately represent the main unit outputs and capture some relevant internal variables [3]. The monitored outputs are the power generated by turbine and the throttle pressure. The internal variables are the steam flow, generated steam and drum pressure.

A concrete case is the central heating power plant of Timisoara, where the modeled system is divided into three 49 t/h coal fired boilers having the capacity of producing 100 t/h steam at pressures up to 18.3 bars. These units use the steam for internal and external consumers and for electric power generation by passing the superheated steam to a 16 MW turbine. The boilers are small cogeneration units compared to the ones described in [2], due to their double functionality.

For this case, the paper presents an open loop simulator based on a simplified boiler model, used for dispatcher training to increase system safety and reliability. The simulator is built under the hardware-in-the-loop (HIL) concept in LabVIEW to model the real system using live data. In the next stage, it allows the integration of a rapid-control-prototyping (RCP) system with the HIL simulated process for testing and tuning in real time. The final integration of the control system with the real process will be in a short period.

On the other hand, the paper also presents how to put a LabVIEW virtual instrument (VI) – “the simulator”, into a real time application, although this is done only for test purpose.

The difference between running in real-time under a real-time operating system (RTOS) - in LabVIEW, or using a general purpose operating system (i.e. Windows - GPOS), is that the RTOS assures determinism by executing the simulator as a time critical priority program on the real-time target (hardware) leaving the interface to be executed by the host (i.e. PC, touch screen).

The paper is organized as follows. Section II presents a couple of tested models, general boiler schematics and means of adapting model parameters and structure to the desired plant. Section III presents the LabVIEW code for implementing the simulator and explanations regarding how to switch this code to real-time. Section IV presents simulation responses and results. Section V is for conclusions.

II. BOILER PROCESS AND LOW ORDER MODELS

A general plant schematics is presented in Fig. 1. The water, entering on the boiler water walls, is transformed into steam due to heat transfer from the furnace to the pipes metal. The steam is gathered in a drum, which sends it to a super heater for transforming wet steam to saturated steam. After leaving the boiler unit, the steam is sent to a turbine, which generates electric power.

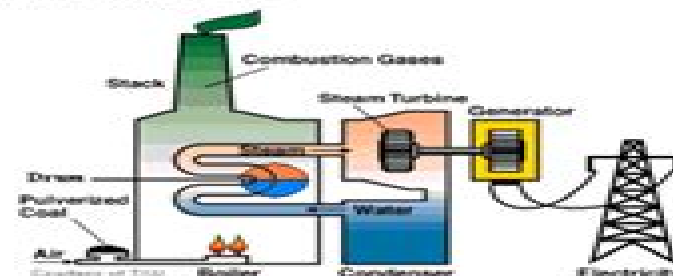


Fig. 1. General diagram of boiler-turbine unit.

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