Dynamic simulation assisted power plant engineering

CASE 1: NEW CFB BOILER AND CONDENSING TURBINE FOR A PAPER MILL

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INTRODUCTION

Combining existing and new power plant brings challenges for process design, controls and overall mill operation

INTRODUCTION AND CHALLENGES

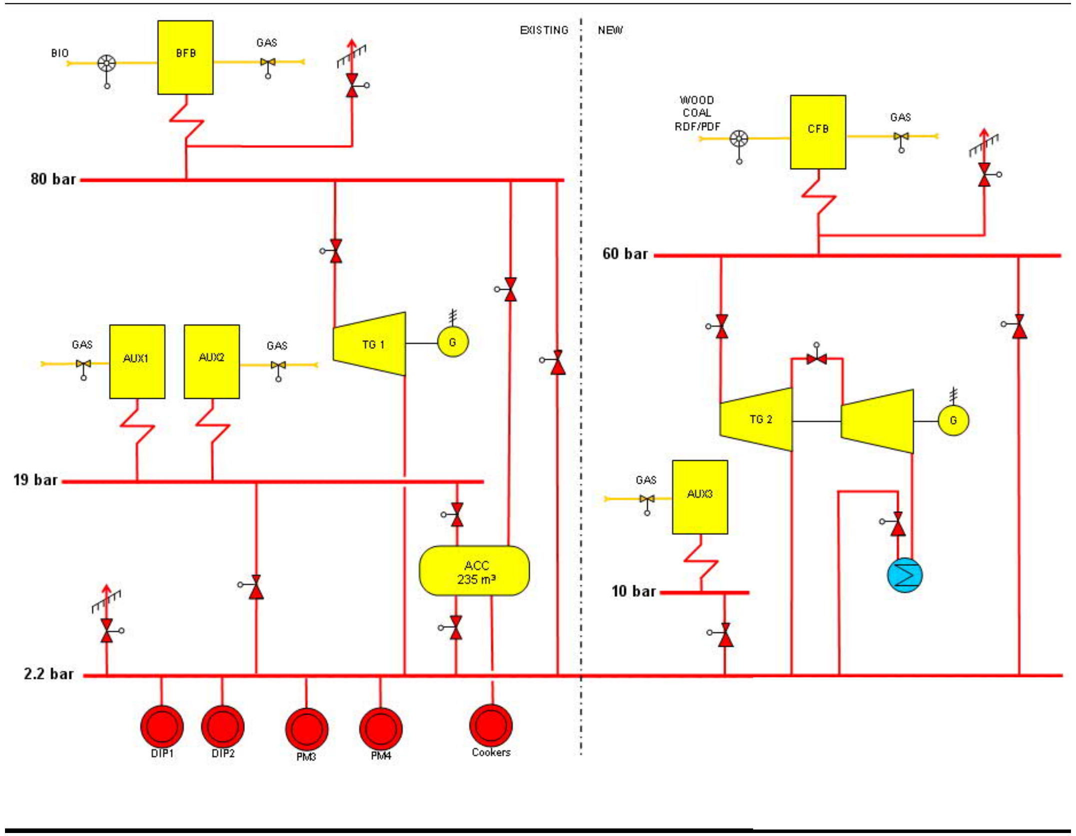
- Industrial power plant in Europe, produces steam for paper mill
- A new CFB boiler, a condensing turbine and a back-up auxiliary boiler were installed and started in 2010
- Existing steam-net controls had to be combined together with the new steam-net controls

Previously part of the process steam was purchased from a nearby utility: steam pressure was controlled with the valve on the boundary. The new boiler delivers this part of the steam and the pressure will be controlled by the new condensing turbine.

The client wanted to check the new steam-net behavior, especially during a condensing turbine trip

- challenging due to small turbine by-pass capacity
- risk of tripping the CFB → risk of tripping also paper machines in the worst case

POWER PLANT FLOW SHEET

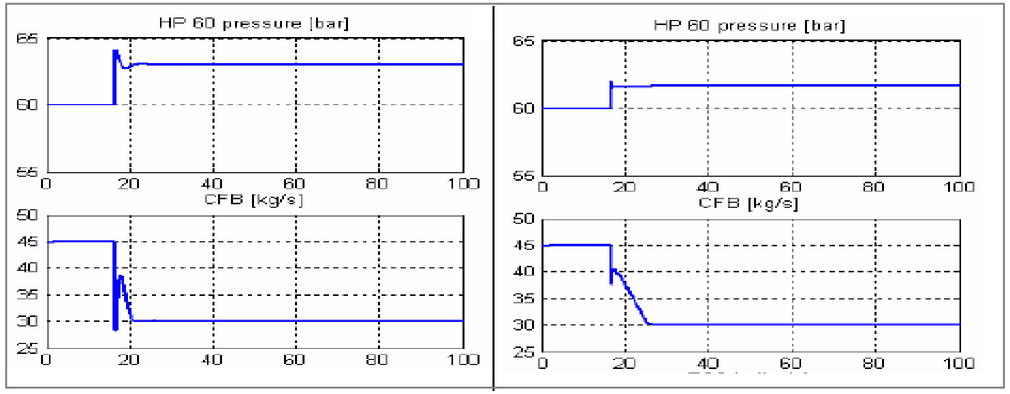


Dynamic simulation provides answers for the most challenging operational disturbance scenarios

SIMULATION RESULTS

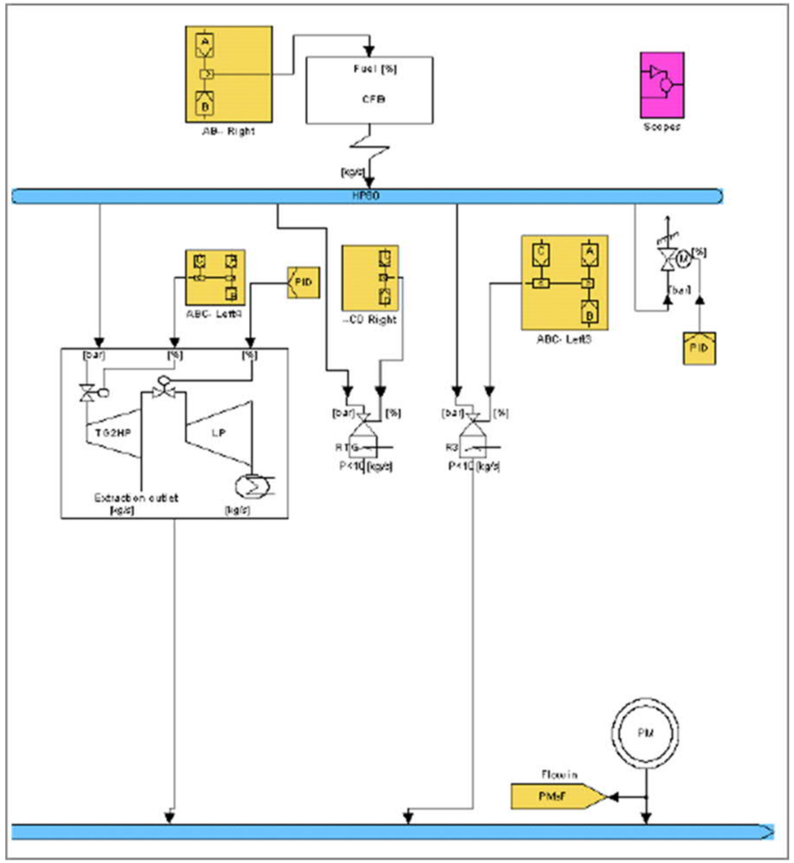
A simulation study was carried out. The results indicated the following:

- During normal operation the new condensing turbine was able to control LP pressure during worst disturbances
- In order the power plant to survive a turbine trip, the turbine and condenser by-passes had to be be fast-opened, and the start-up valve must be equipped with a fast pneumatic actuator
- Turbine control system needed modifications in order to function well with the existing power plant
- The new power-plant steam pressure controls had to be specified in order to tie them together with the existing ones



Some turbine trip simulation curves, without and with fast start-up valve actuators. Drum level drops considerably in the first case.

PARTIAL AFRY MODYSIM™ MODEL OF THE CASE MILL



AFRY participates in all phases of the steam-net control project

Detail engineering | Configuration | Commissioning

Process engineering

C&I engineering

Steam-net control phases

Specification | DCS configuration | FAT | Start-up

Kick-off | Pre-FAT

Control concept specification Power plant operating modes – BOP dimensioning checks (accumulator volume + valve dimensioning) – Configuration instructions for the automation and turbine supplier	Supervision of configuration – Kick-off (1 day) – Pre-FAT (1 day) – FAT (2-5 days)	Start-up assistance and tuning – Initial controller parameters obtained from the model – AFRY's specialist tunes the controllers, and makes sure that the steam network behaves well and causes no troubles during the commissioning

- A fully functioning steam-net control configuration was developed during the dynamic simulations
- In order to implement the controls and achieve the simulated results, a specification for the control configuration was developed
- Specification was given to automation and turbine suppliers as the basis for their control system design and programming work
- AFRY supervised the configuration and participated the steam-net control FAT
- Training sessions for the mill personnel were carried out by AFRY on site
- AFRY steam-net personnel participated in the start-up, commissioning and finetuning the steam-net controllers

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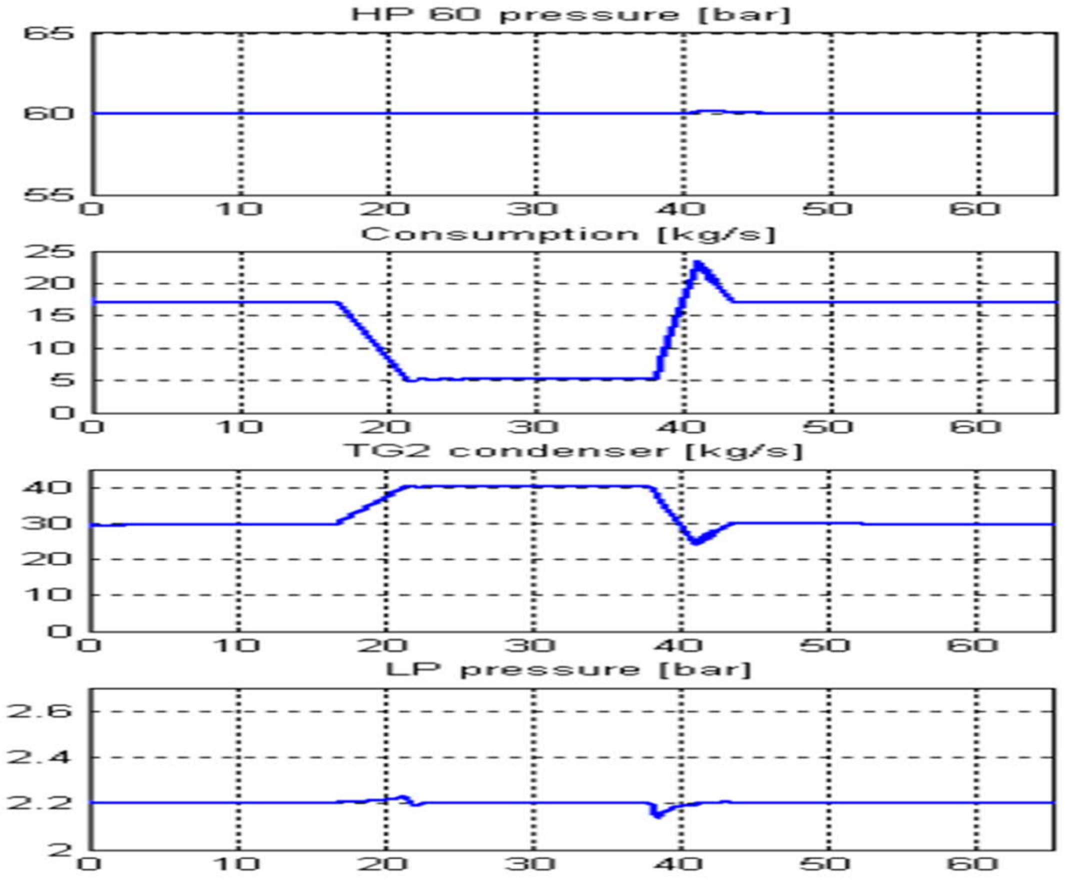
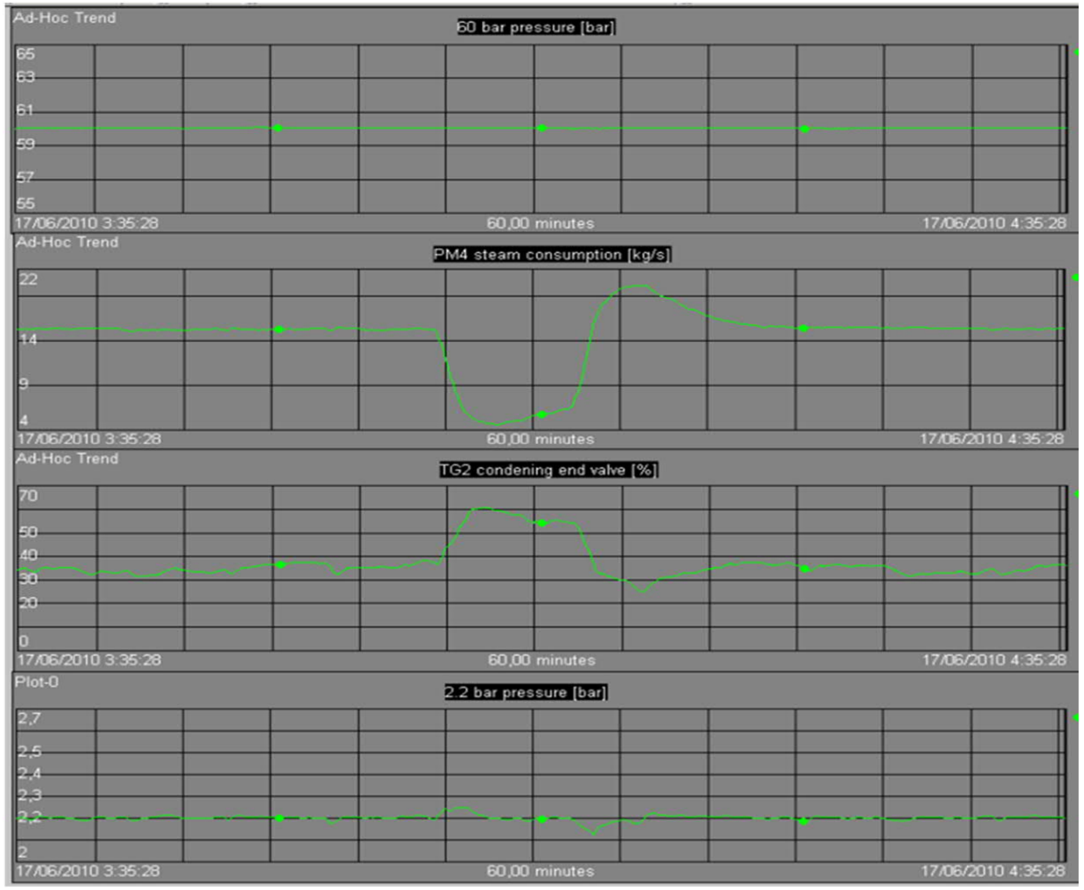
After implementation and fine-tuning, the real-life curves from the mill matched the simulation results

PAPER MACHINE WEB BREAK SIMULATION RESULTS



PAPER MACHINE WEB BREAK, ACTUAL TREND CURVES



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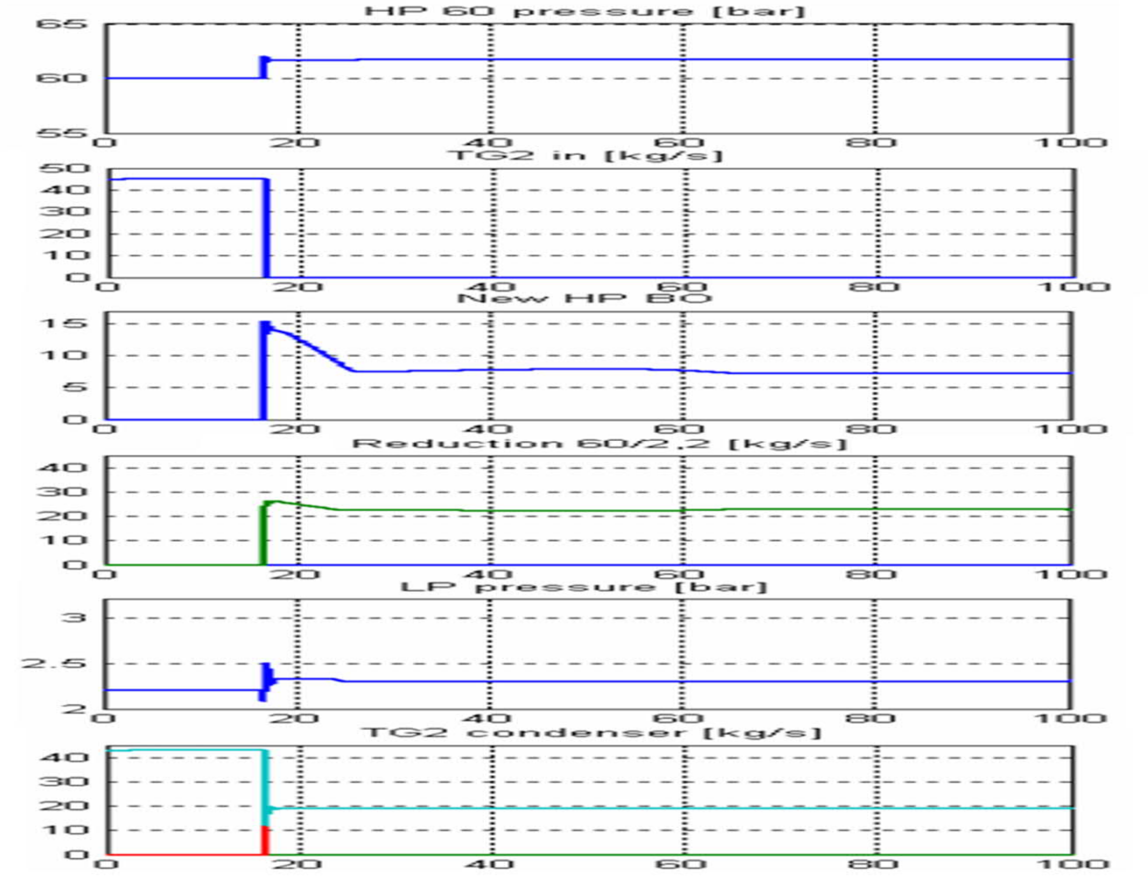
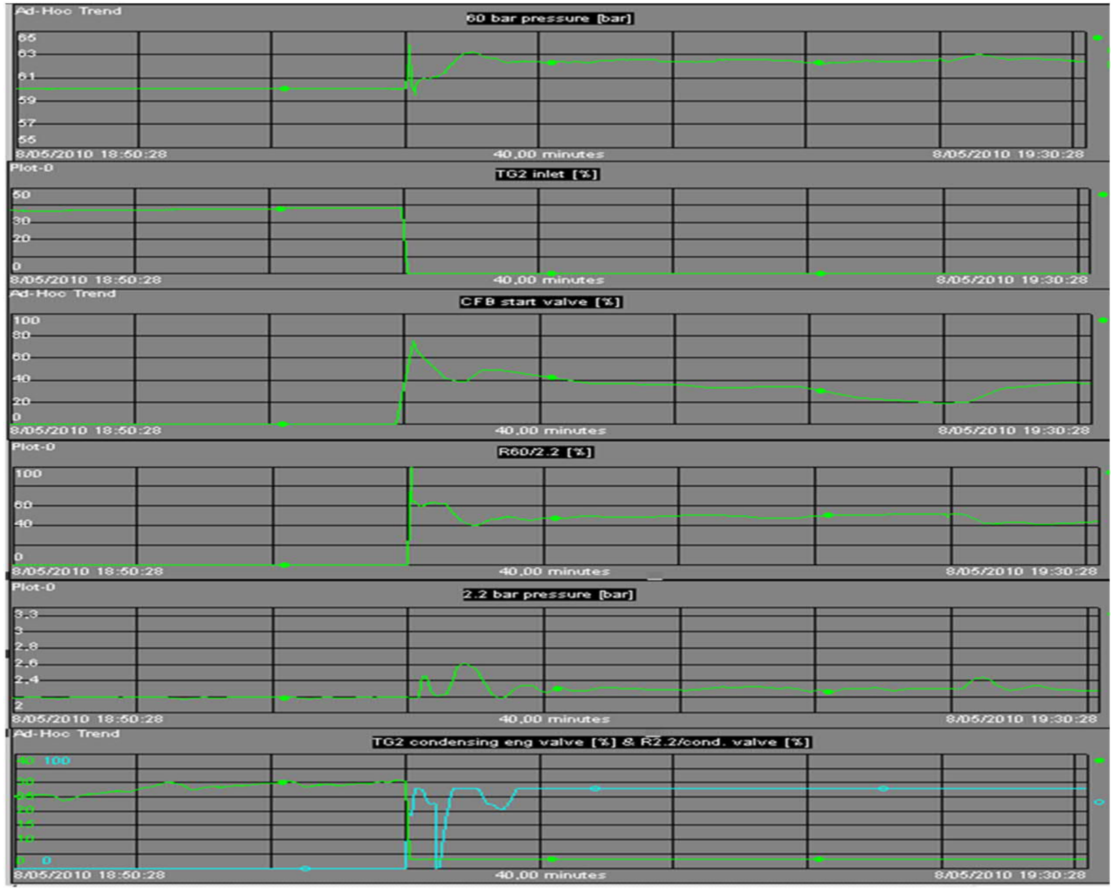
SIMULATED VS. REAL-LIFE CURVES: TURBINE TRIP

After implementation and fine-tuning, the real-life curves from the mill matched the simulation results

STEAM TURBINE TRIP SIMULATION RESULTS



STEAM TURBINE TRIP, ACTUAL TREND CURVES



With dynamic simulation assisted power plant engineering, the commissioning went fast and flawlessly, and results were excellent

- The worst disturbances that can take place during the new power-plant operation were tested already in the beginning of the engineering
  - Process and automation engineering were supported during the entire power-plant design with the power-plant control requirements
  - The modifications that were required in the DCS and in the turbine control system were specified at an early stage instead of fixing them by trial and error during the commissioning
- The steam-net control system developed during the simulations worked perfectly from the very first moment allowing to reach a very good pressure stability (±0.05 bar during normal operation, ±0.1 bar during upsets) and an eased start-up
- Steam-net control commissioning was over in just few weeks instead of several months
- Back-pressure power generation of the turbines will be maximised during the operation, because the pressure will be maintained as stable and as low as possible under all circumstances.

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