FLOWNEX®
SIMULATION ENVIRONMENT

CASE STUDY

OPTIMIZATION OF CONDENSATE EXTRACTION PUMPS' FLOW CONTROL

This case study shows how Flownex was used to evaluate and optimize condensate extraction pump (CEP) flow control at a 4100 MW coal-fired power station. The plant originally used valve throttling to regulate condensate flow, wasting more than 30% of the developed pump head under normal operation.

FOSSIL FUEL POWER GENERATION

CHALLENGE:

A 4100 MW coal-fired power station relied on conventional valve throttling to control condensate extraction pump (CEP) flow. This approach wasted more than 30% of the developed pressure and flow under normal conditions, increasing power consumption and operating costs. With rising energy costs and growing focus on plant efficiency, the utility sought to identify an alternative control method that could reduce power use without compromising performance.

BENEFITS:

Flownex was chosen because it allowed engineers to:

- Test multiple retrofit control options without disturbing plant operations.
- Perform fully transient system-level simulations to capture the pump's response under changing load conditions.
- Visualize and compare power consumption in real time using built-in interfaces and Excel integration.
- Quantify potential savings before committing to physical modifications.

SOLUTION:

Using Flownex SE, engineers simulated the existing CEP system and compared fixed-speed operation with a variable speed drive (VSD) retrofit. The model accurately predicted the impact of reduced pump speed on power draw and system pressure.

Results showed that switching to a VSD could reduce pump input power by up to 39% (≈362 kW), with additional savings possible during variable load operation. The analysis indicated a payback period of approximately 1.5 years, demonstrating a clear financial incentive for implementation.

INTRODUCTION

Most condensate extraction systems in thermal power stations still use throttling valves for flow control, leading to substantial efficiency losses. Variable speed drives offer a modern solution by adjusting pump speed to match system demand, allowing operation closer to the pump's Best Efficiency Point (BEP). This means the pump can deliver the same flow rate at a lower head, as there is no throttling valve adding extra resistance to the system. This concept is demonstrated in Figure 1 below.

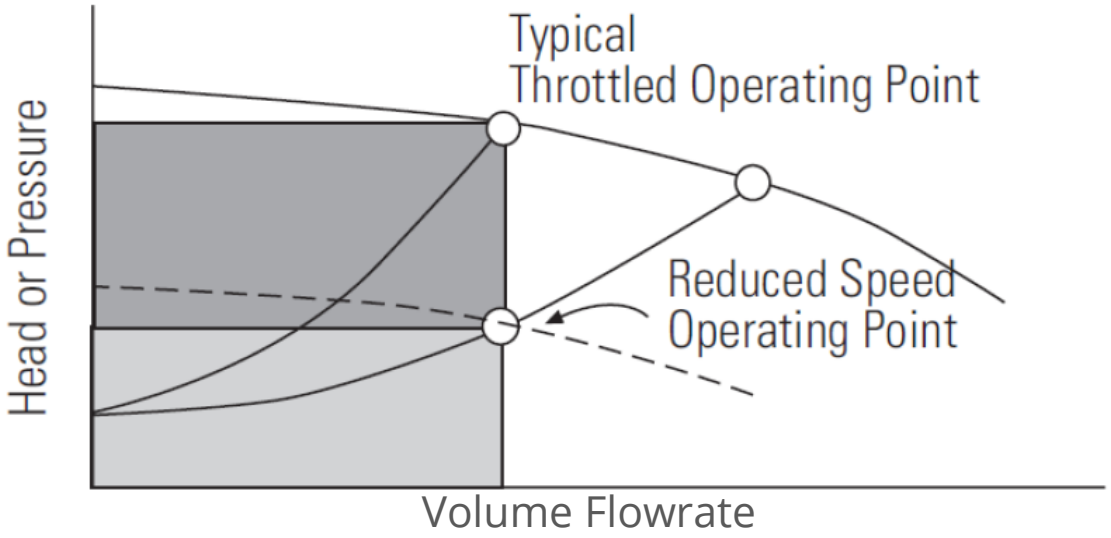

Figure 1: VSD control vs throttling

Unlike throttling, VSD control allows pumps to operate along multiple speed lines. This study used Flownex to quantify the benefits of such a retrofit on an operating power station.

SYSTEM DESCRIPTION

The modelled system consisted of two CEPs drawing condensate from the condenser, pumping through three low-pressure feedwater heaters and into a deaerator. The existing setup included a control valve for flow regulation and a recirculation valve for maintaining minimum flow during low-load operation.

OBJECTIVE OF SIMULATION

To determine the achievable reduction in pump power consumption and corresponding return on investment when replacing mechanical throttling with VSD control.

FLOWNEX MODEL

A detailed Flownex model of the condensate system was developed, including both control configurations—throttled and VSD-driven. The model featured interactive track bars to vary plant load, with dynamic visualization of pump power demand and condensate flow response.

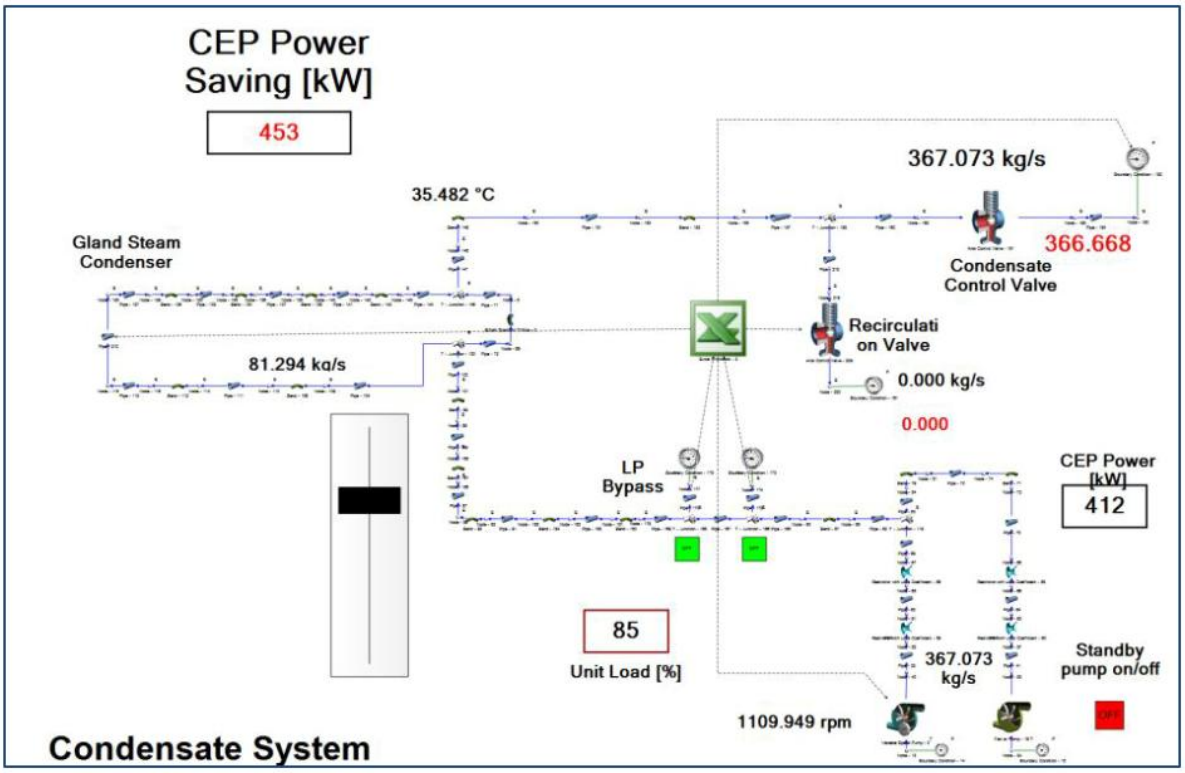

Figure 2: Condensate system

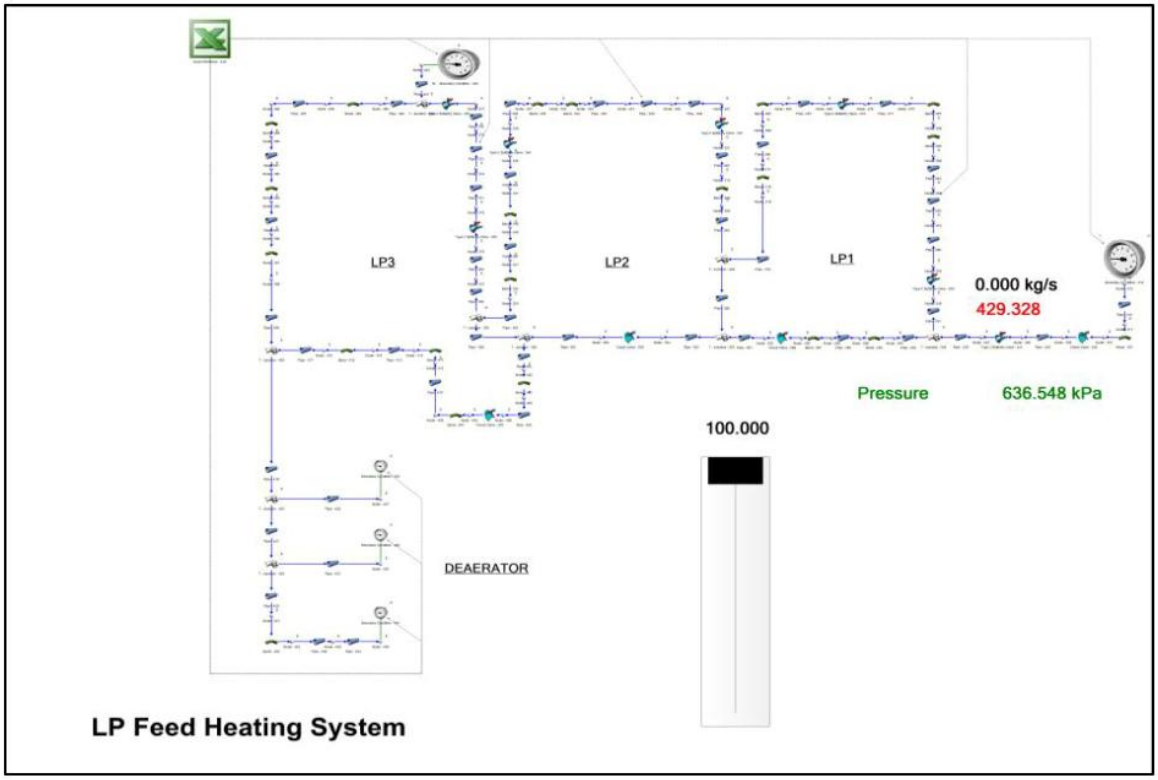

Figure 3: Low pressure feedwater heating system

DESCRIPTION OF SIMULATION

A transient simulation was performed to represent variations in unit load over time. The model calculated instantaneous and average power savings between the two control methods and provided system feedback through the HMI and Excel-linked dashboards.

RESULTS

The Flownex analysis revealed:

- 34.5% (≈320 kW) power savings under typical operating conditions.
- Up to 52.4% (≈455 kW) savings at lower average loads.
- Actual measured efficiency gains corresponding to ≈39.1% (≈362 kW) power reduction.
- Estimated ROI of 1.5 years for VSD implementation.

These findings guided the selection of the VSD retrofit as the preferred option for improving energy efficiency.

CONCLUSION

Flownex provided engineers with a system-level understanding of how different flow control methods affected pump performance and energy use. The ability to perform accurate, dynamic simulations enabled confident decision-making on a retrofit that significantly reduced power consumption and operational cost.