

Abstract

Optimisation of belt conveyors system

The phasing out of fossil fuels as a source of electricity generation is definitive. However, shifting the economy from a coal-based one to one that is reliant on utilising renewable generation sources is time-consuming and requires reorganising technological developments, social factors, labour training, legal, and other issues. For financial reasons, measures aimed at reducing CO₂ emissions to below 550 g/kWh are crucial, while for social reasons, minimising acoustic impact is also very important.

The Połaniec Power Plant has taken on the challenge of reducing CO₂ emissions by co-firing biomass with coal. This requires technological and organisational optimisation of the biomass transport to the power plant, its unloading and storage, as well as internal transport. Optimising the internal transport of biomass using conveyor belts is a task being carried out as part of an implementation doctorate. The optimisation criteria adopted aligned both the “550 limit” and meeting environmental noise emission requirements while maintaining the planned power performance.

To identify the optimal solution for the “550 requirement” and acoustic impact, a proposal for modernising the conveyor belt system was prepared. Subsequently, the operation of various variants of the Biomass Fuel System was simulated. Modernising to ensure the planned energy efficiency and reduced CO₂ emissions, as well as the operation of the conveyor belt system, while taking into account its reduced acoustic impact on the environment. For simulation purposes, a “digital twin” was developed, enabling both spatial visualisation of the Biomass Transport System and reflection of the system’s performance and acoustic impact.

The scientific value of the study in the context of the development of the discipline of Mechanical Engineering results from the consideration of various legal, environmental, and social criteria in the optimisation of the Biomass Power System installation, as well as the preparation and use of a multi-criteria simulation tool, a “digital twin”, and an innovative multi-criteria and multi-fuel optimisation.

The utilitarian nature of the study is demonstrated not only by the preparation of a specific implementation solution, but also by the model's potential for use by any energy company planning to adapt its operations to various external requirements in situations where it is impossible to utilise existing resources. The flexibility of the proposed solution stems from both the ability to expand the scope of the model's criteria and the ease of adapting the model to changing requirements within these criteria.