Parametric optimization and retrofitting of the tea withering process to maximize energy savings; a mathematical modelling approach case study: Talawakelle Tea Estates PLC

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Tea industry in Sri Lanka holds significant economic importance, contributing substantially to the country's overall revenue and foreign exchange earnings. However, the industry faces a critical challenge in the form of high production costs, primarily driven by the considerable energy consumption involved, including the usage of electricity and fuelwood. Among the various stages of tea production, the withering process emerges as the most energy-intensive unit operation. Traditionally, the control of the withering process has relied on the subjective judgement and experience of supervisors based on factors such as temperature, leaf characteristics, and environmental conditions. Consequently, ensuring optimal control and energy efficiency in the withering process has become a considerable challenge. To address this challenge and improve energy efficiency, a model was developed to predict moisture content during the withering process. The model also aims to optimize the control of air flow rate and temperature based on these predictions. Simulations were conducted using the model to identify the optimal withering time for a given set of inputs, with the objective of minimizing both electrical and thermal energy consumption. Simulation results revealed that the lowest electrical energy consumption was achieved with a withering time of 14 hours, while the lowest thermal energy consumption occurred at 10 hours. These findings highlight the potential for optimizing flow rate and temperature variations at different stages of the withering process to achieve energy efficiency. Development of this predictive model and its subsequent simulations provide a foundation for the future automation of the tea withering process.

Keywords: Tea withering, mathematical modelling, parametric study, optimization, energy saving