УДК 681

MODEL PREDICTIVE CONTROL FOR ENHANCING THE EFFICIENCY OF ORGANIC RANKINE CYCLE SYSTEMS

Master's Student Manzungu Z.[1]
Supervisor Eng. Kuno V.[1], PhD Vorobey R. I.[2]
[1]Harare Institute of Technology, Harare, Zimbabwe
[2]Belarusian National Technical University, Minsk, Belarus

This study investigates the application of Model Predictive Control (MPC) to optimize the performance of Organic Rankine Cycle (ORC) systems, with a particular focus on temperature control in the boiler. ORC systems are widely utilized for waste heat recovery and renewable energy applications due to their ability to convert low-grade heat into useful work. However, the efficiency of ORC systems is highly sensitive to varying operating conditions, such as fluctuations in heat source temperature and load demand. Traditional control strategies, such as Proportional-Integral-Derivative (PID) controllers, often fail to maintain optimal performance under these dynamic conditions, leading to suboptimal energy conversion and reduced system efficiency.

To address these challenges, an advanced MPC-based control strategy was developed and implemented using Python-based simulations. The MPC approach leverages a dynamic model of the ORC system, which was constructed using fundamental thermodynamic equations and heat transfer principles. The working fluid selected for this study was R245fa, a commonly used refrigerant in ORC systems due to its favourable thermodynamic properties. The MPC algorithm was designed using the do-mpc and CasADi libraries, which provide robust tools for optimization and control. The algorithm predicts future system behaviour over a finite time horizon and computes optimal control actions to maintain the desired boiler temperature, thereby enhancing the overall efficiency of the ORC system.

The simulation results demonstrate that the MPC-based control strategy outperforms traditional PID controllers in terms of set point tracking, disturbance rejection, and energy efficiency. The MPC controller effectively handles the nonlinearities and uncertainties inherent in ORC systems, ensuring stable operation under varying conditions. This study highlights the potential of MPC as a powerful tool for improving the performance of ORC systems in waste heat recovery and renewable energy applications. Future work could explore the implementation of the proposed MPC strategy on a physical ORC system to validate the simulation results and further optimize the control parameters.

УДК 681

AI BASED PREDICTIVE ANALYSIS WATER CONSERVATION MANAGEMENT SYSTEMS

Student Marozva M.[1]
Lecturer, Eng. Rushambwa M.[1], Palaniappan R.[2]
[1]Harare Institute of Technology, Harare, Zimbabwe
[2]College of Engineering, University of Technology, Bahrain

Water bodies (dams, lakes, rivers) are very crucial for the ecological balance, agricultural productivity and the socio-economic development of any country. These resources support various activities such as agriculture, fishing, mining, recreation, industry and hydropower. These water bodies, water reservoirs, their sustainability is however increasingly threatened by challenges like climate changes including severe droughts, erratic rainfall patterns, and pollution from industries, exacerbated by the countries heavy reliance on water which accounts for 90 % of its supply of any country around the world. Climate change has caused negative impacts in the deterioration of theses water bodies impacting especially agriculture and food security. Various and different methods have been applied and tested to address and come up with the best water quality predictive and management systems that will be able to help and advice stakeholders in applying the necessary and efficient methods to conserve and maintain high quality water bodies. There is need for an efficient innovative water conservation management system that is efficacious which can predict and mitigate risks to water resources.