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System Modeling-Based Technologies for Improving Industrial Energy Utilization Efficiency

With the rapid development of industrialization, energy consumption constitutes a significant portion of industrial production costs. Improving industrial energy utilization efficiency not only reduces operating expenses but also mitigates greenhouse gas emissions and promotes sustainable development. However, traditional energy efficiency improvements often focus on individual equipment or localized processes, lacking a system-level perspective to capture energy flows, loss distribution, and process interactions comprehensively. System modeling-based approaches have therefore become essential for achieving holistic optimization of industrial energy systems.

System modeling enables quantitative and coupled analysis of energy input, conversion, and output across industrial production processes. By constructing energy flow networks and process models, it is possible to identify energy loss points, evaluate the potential benefits of improvement measures, and optimize operational parameters. Moreover, such models can account for varying operating conditions, load fluctuations, and environmental changes, providing scientific decision support for industrial energy management.

This study presents a system modeling-based methodology for improving industrial energy utilization efficiency. The approach integrates energy flow modeling, process coupling analysis, and multi-objective optimization strategies to maximize energy efficiency while maintaining process stability. Simulations of typical industrial workflows are conducted to evaluate the impact of various energy management strategies on system efficiency, energy losses, and emission levels, leading to targeted technical improvement recommendations.

The findings provide engineering guidance for industrial enterprises aiming to enhance energy utilization and achieve sustainable production objectives. The system modeling-based approach can be applied to optimize existing facilities and inform the design of new industrial parks, supporting the development of intelligent and systematic industrial energy management.