Paper 282

Emission Reduction Contribution Analysis of Key Equipment in Industrial Low-Carbon Transitions

Under global carbon reduction targets and low-carbon development strategies, industrial systems—being major contributors to energy consumption and greenhouse gas emissions—play a critical role in achieving sustainable development. Industrial production relies on various energy-intensive equipment, such as boilers, compressors, motor drive systems, and process reactors, whose operational efficiency and technological level directly determine overall carbon emissions. Therefore, identifying key equipment and quantitatively assessing their emission reduction contributions are essential for formulating effective industrial low-carbon transition strategies.

Industrial low-carbon transitions are typically achieved through technology upgrades, equipment replacement, operational optimization, and energy structure adjustments. However, different types of equipment exhibit significant differences in energy consumption patterns, operational characteristics, and emission reduction potential. Relying solely on aggregated energy or emission indicators makes it difficult to accurately capture the actual contribution of individual equipment to emission reduction. Moreover, the coupling of multiple processes and complex operating conditions further complicates the assessment of emission reduction performance at the equipment level. As a result, a systematic and equipment-oriented evaluation framework is required.

This study proposes an emission reduction contribution analysis method for key equipment in industrial low-carbon transitions. By developing energy flow and carbon emission models of industrial systems, the energy consumption characteristics, emission profiles, and technical improvement potential of major equipment are analyzed. Scenario-based evaluations, including efficiency enhancement, operational parameter optimization, and technology substitution, are conducted to quantitatively compare the emission reduction contributions of different equipment. The proposed approach enables the identification of equipment with high emission reduction potential and provides engineering support for prioritized low-carbon retrofitting strategies.

The results offer scientific guidance for planning industrial low-carbon transition pathways, making technology investment decisions, and prioritizing equipment upgrades. This study enhances the effectiveness and economic feasibility of emission reduction measures and provides a systematic analytical framework for promoting efficient, low-carbon, and sustainable development of industrial systems.