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Comprehensive evaluation for different modes of solar-aided coal-fired power generation system under common framework regarding both coal-savability and efficiency-promotability

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Abstract

Solar-aided coal-fired power generation system (SCPGS) is a promising medium-term solution to reduce CO₂ and PM_{2.5} emissions from numerous coal-fired power plants in China, yet lacking of unified theoretical guidance. In the present work, firstly, various specific integration schemes are reasonably generalized and unified by theoretical modelling. Secondly, the “superposition effect” has been revealed that the overall coal-savability of SCPGS is determined by not only the direct benefit due to local integration of solar energy but also the global effect of the integration on the system components in a superposition way. Meanwhile, the “promotion effect” has been revealed that the promotability of SCPGS on solar thermal exergy is primarily dependent on the higher-temperature Rankine cycle but sensitive to the energy level coupling between the solar thermal energy and the working fluid. Thirdly, the comprehensive evaluation factor (f), which serves as the common evaluation index between different SCPGSs considering both the coal-savability and efficiency-promotability, is proposed. Finally, with the help of the comprehensive evaluation factor, examples of application are given as demonstration for the comprehensive evaluations between 12 individual cases of SCPGS within a common framework. The present work is expected to fundamentally guide the future research and application of SCPGS.

Keywords: Solar-aided coal-fired power generation; Coal-savability; Efficiency-promotability; Comprehensive evaluation; Solar share; Energy level

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