Exploring Extreme Voltage Events in Hydrogen Arcs within Electric Arc Furnaces	
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Abstract: This study highlights the potential utilization of hydrogen gas in electric arc furnaces for achieving cleaner and more sustainable steel production. The application of hydrogen offers a promising path for reducing carbon emissions, enhancing energy efficiency, and advancing the concept of "green steel". This study employs a 2D axisymmetric induction-based model to simulate an electric arc under atmospheric pressure conditions. We conducted numerical simulations to compare compressible and incompressible models of an electric arc. The impact of compressibility on hydrogen arc characteristics such as arc velocity, temperature distribution, and voltage drop were investigated. Additionally, different applied current arcs were simulated using the compressible model. When compared to an incompressible arc, the compressible arc exhibits a higher voltage drop. This higher voltage drop is associated with lower temperatures and lower arc velocity. A rise in applied current results in an upward trend in the voltage drop and an increase in the arc radius. In addition, the increased applied current increases the probability of voltage fluctuations. The voltage fluctuations tend to become more extreme and exert more stress on the control circuit. This has an impact on emerging electric arc technologies, particularly those involving the use of hydrogen. These fluctuations affect arc stability, heat output, and the overall quality of processes. Thus, the precise prediction of voltage and the ability to stabilize the operation is critical for the successful implementation of new hydrogen technologies.