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Effects of the Transport Properties of Gaseous Medium on Arc Behaviors in a Supersonic Nozzle

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Modern high-voltage auto-expansion circuit breakers utilize the gaseous medium flowing through a supersonic nozzle to produce adequate conditions for arc quenching at current zero. The behaviors of arcs burning in such nozzles are closely related to the properties of the medium. SF6 is currently used as working medium because of its excellent dielectric properties. However SF6 is a strong greenhouse gas. The replacement of SF6 with a more environmentally friendly gas is becoming an increasingly interesting research topic. PC-based arc modelling has been carried out for a supersonic nozzle with geometry and dimensions comparable to industrial products [1]. The influence of material properties on arc quenching capabilities has been studied for the three different gases of SF6, CO2, and N2. The results show that, with the nozzle geometry under investigation, the temperature fields with the three fillings are similar during the high current period. However, when the current drops below 30 kA, especially when the current drops towards its final zero, the arc column could not shrink in radial direction properly with CO2 and N2. This phenomenon also was found in a 245 kV auto-expansion circuit breaker [2]. The work reported here is an extension of the work in [1] and [2]. It focuses on the effects of the transport material properties of the mediums on arc behaviors. The supersonic nozzle of Campbell et al [3] used in [1] is also used in the present work for the comparison's sake. The thermal recovery and dielectric recovery processes following the extinction of an arc in the supersonic nozzle have been simulated. The RRRVs (rate of rise of recovery voltage) have been predicted for the different transport properties under the same thermodynamic properties and other operation conditions. The effects of transport properties on the interruption capability will be analyzed in detail.

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