The correlation of magnetic, gas dynamic and thermal effects on arc mobility in low contact velocity circuit breakers

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Abstract -**This paper examines arc root mobility in relation to magnetic and gas dynamic forces in low contact opening velocity circuit breakers (1 m/s). Arcing conditions of interest are short circuit faults (10^3-10^4 A) in low voltage (220-380VAC) circuit breakers. Previously published experimental results have shown how the gas flow and venting in the contact region affect the arc root mobility [1,2]. These were based on experimental data from a flexible test apparatus, a solid state high-speed arc imaging system and pressure transducers. In this paper the interrelation of gas dynamic and magnetic forces is investigated further by developing relationships between electromagnetic forces and high temperature gas dynamic flows. New semi-empirical modelling and experimental results are presented in terms of electrical and thermal energy transfer between the arc and the gas flow. The influences of magnetic field on the relationships between arc power, arc voltage, arc current and arc energy are discussed. The effects of heat transfer and thermal power on the gas flows in the arc chamber are explored. These effects are discussed particularly in relation to arc root motion in low contact opening velocity systems. Some features of arc root mobility, which had hitherto been anomalous, are explained. Furthermore, these are used to extend and develop models of arc root commutation. This study provides a vital step in the development of a consistent model of the arc structure and motion in miniature circuit breakers operating at low contact opening velocity.**