Electrical arc behavior, controlling and their applications in switchgear

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Switchgear is the vital equipment widely used in the electrical power system, to protect the whole system from fault damage. Electrical arc plasma is a normal phenomenon appeared during the switchgear interrupting the current. Understanding and controlling of arc plasma is very important to improve switchgear performance, propose new scheme for current interruption and greenhouse gas SF6 processing. This talk presents arc behavior and controlling for switchgear, including arc erosion measurement, arc oscillation controlling in DCCB and arc processing SF6 gas for environmental protection. Research results are used and support greatly the development of the equipment.

Firstly, the arc erosion behavior is described here based on the measurement. Electric arc with high temperature up to several tens thousand K, leads to serious erosion to surroundings, especially to electrode. Measurement of arc erosion is a challenging work due to the high temperature of the arc and quick action between arc and electrode. The special high-speed visualization technique is proposed. The arc erosion behavior is achieved by a high-speed camera coupled with the narrow band-pass filter. ICCD is used to capture the thermal image of the electrode coupled with the beam splitter equipment and optic filter. Based on this method, the total mass and trajectories of droplets splashed from the electrode surface under different current, arc medium and electrode materials are recorded and analyzed.

Secondly, arc control is helpful to propose new current interruption principle. DC current interruption is much more difficult compared with AC interruption, especially in medium or high voltage area. The exiting HV DCCB, such as hybrid circuit breaker is very expensive, which is not favorable to be extended in real system. This talk proposed one new method for DC interruption. Through the external magnetic field excited by AC source, it makes the arc voltage oscillation and achieves the current zero of mechanical switch. Fig.3 shows the arc voltage oscillation influenced by a magnetic field. The frequency and amplitude of oscillation is controlled by magnetic field. Based on the arc oscillation, the DC current flowing through the mechanical electrode can decrease to zero.

Finally, the degradation of SF_6 gas for switchgear based on arc plasma is presented here. SF_6 gas is widely applied as the insulation and current interruption medium in the high voltage switchgear. However, SF_6 gas used in existing equipment will exit the application due to its greenhouse gas effect. Arc plasma torch with high temperature is adopted to decompose SF_6 and form nontoxic products. The setup of SF_6 degradation experimental installation is shown as Fig.2. The tested degradation rate in our lab is above 99%. Compared with other methods, SF_6 degradation with arc plasma can obtain a higher degradation rate.

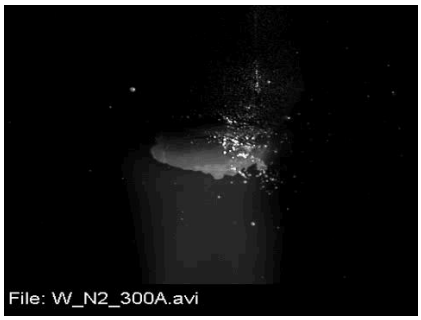

Fig.1 The arc erosion to the Tungsten electrode in N_2

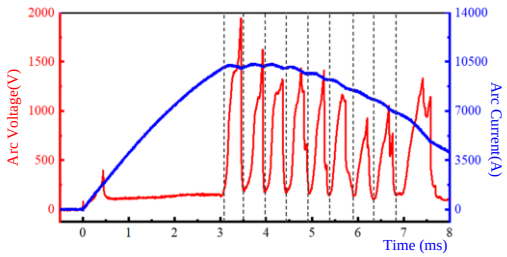

Fig.2 Arc voltage oscillation affected by magnetic field

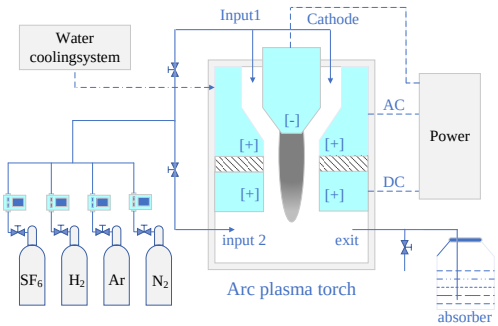

Fig.3 Setup of SF6 degradation experimental installation

References

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