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Electric Discharge Generation in MeOH Supercritical Fluid

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Electric breakdown and discharge propagation in supercritical fluids (SCF) mostly generated in CO2 and N2 were described in several works [S. Stauss et al, PSST, 27 (2018), 023003]. Study of the mechanisms of electric breakdown and discharge dynamics in SCFs is a fundamental challenge and promises well-recognized practical benefits in different engineering areas including fuel injection techniques, protection against deadly breakdowns in electrically-insulating liquids, etc. This study considers a self-sustained system where a high-voltage discharge first transfers a weakly-conductive liquid (MeOH) to a SC state, then exists in the SCF as an extended high-current plasma filament. The SCF plasma is generated in a rigid transparent test cell under the following conditions: discharge length up to 20mm; applied voltage up to 10kV; electrical current up to 100A; initial pressure P=1bar; maximal pressure within SCF up to 100bar. Diagnostics include electrical probes, fast camera imaging, schlieren visualization of the hydrodynamic processes, laser tracking of interfaces, and optical emission spectroscopy. A non-ideal plasma state is considered with electron density exceeding 3e19 cm-3 measured by Stark broadening of the Hα line. Extra attention was paid for a phase of expansion and condensation of the SCF. In terms of nucleation dynamics, two different scenarios are discussed: ion-ion conductivity (liquid-like SCF) and electron-ion conductivity (gas-like SCF). The second scenario potentially yields a great charge accumulation and prevention of further condensation of the multiphase mixture.