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Study on the characteristics of the shock wave induced by underwater pulsed current discharge

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A dynamic shock wave induced by underwater high pulsed current discharge has a wide potential applications in industrial and civil fields, such as rock fragmentation, electrohydraulic cleaning, and oil stimulation, etc. In order to promote the application of the dynamic shock wave, a test stand of underwater pulsed current discharge is designed and constructed. The main capacitor is 3 μF, and the charging voltage is 30 kV. Under the needle-needle electrode system with the gap distance of 10 mm, the intensity of the dynamic shock wave induced by the electrohydraulic effect is measured by a pressure sensor of PCB 138A01. Based on the electrical parameters and time-resolved observation of the arc and bubble development from a high speed camera, the factors that affect the shock wave intensity are analyzed. It is showed that the arc length has a great effect on the intensity of shock waves. As the arc length increases, the main discharge current decreases. However, a more intensive pressure is observed. It is concluded that the development of arc length is inconsistent, and arc expansion speed is not uniform. Moreover, the intensity of shock wave is closely related to the power and energy dissipated into the discharge arc channel. The longer arc and the quicker arc expansion can lead to a higher power and energy deposited into the arc channel, which can activate a stronger shock wave. Finally, a hydraulic fracturing is carried out to analyze whether the dynamic shock wave can achieve the fracture creation of a cement sheath. Results show that the shock wave can result in the increase of the permeability. The intensity of shock wave can determine the fracturing pattern and the number of pulsed discharges.

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