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Study on Validity of 1-D Spherical Model on Aqua-plasma Power Estimation With Electrode Structure

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The aqua-plasma is the non-thermal plasma in electrical conductive electrolyte by generates the vapor film layer on the immersed metal electrode surface. This plasma can generate the hydroxyl radical by dissociate the water molecule with the plasma electron. To develop the plasma discharge device for high efficiency in the hydroxyl radical generation, proper model for estimation of plasma power is necessary. In this work, the 1-D spherical model was developed, considering temperature dependence material constants. The relation between the plasma power and hydroxyl generation was also studied by the comparison between the optical emission intensity from the hydroxyl radical using monochromator and estimated plasma power. First, the thickness of vapor layer thickness was estimated using the Navier-Stokes fluid equation in order to calculate the discharge E-field inside vapor layer. Using the E-field magnitude and power balance on the plasma generation, it was possible to estimate the plasma power. The plasma power was assumed to uniformly fill the vapor layer and the temperature of vapor layer was fixed in the boiling temperature of electrolyte, 375K. In the experiment, the aqua-plasma was discharged in the saline by applied the voltage on the bipolar electrode. The range of applied voltage was 234 to 280V-rms in the frequency of 380 kHz. Two type electrodes were produced with two Φ0.2 tungsten. The plasma power was estimated from the V-I signal from the two high voltage probes and current probe. The estimated plasma power agreed with the profile of emission intensity when the plasma discharged between the metal electrode and vapor layer surface. However, when the plasma discharged between the metal electrodes, the increasing rate of emission intensity was lower than the increase of plasma power. It implies that the surface reaction is more sufficient rather than the volume reaction in the radical generation, due to the high density of water molecule in the liquid.