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ORIGINAL PAPER

Numerical Experiments on Oxygen Soft X-Ray Emissions from Low Energy Plasma Focus Using Lee Model

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Abstract The X-ray emission properties of oxygen plasmas are numerically investigated using corona plasma equilibrium model. The Lee model is here modified to include oxygen in addition to other gases. It is then applied to characterize the Rico Plasma Focus (1 kJ), finding a oxygen soft X-ray yield (Ysxr) of 0.04 mJ in its typical operation. Keeping the bank parameters and operational voltage unchanged but systematically changing other parameters, numerical experiments were performed finding the optimum combination of pressure = 3 Torr, anode length = 1.5 cm and anode radius = 1.29 cm. The optimum Ysxr was 43 mJ. Thus we expect to increase the oxygen Ysxr of PF-1 kJ thousand-fold from its present typical operation; without changing the capacitor bank, merely by changing the electrode configuration and operating pressure. The modified version of the Lee model code is also used to run numerical experiments with oxygen gas, for optimizing the oxygen soft X-ray yield on the new plasma focus device PF-SY2 (2.8 kJ). The static inductance L_0 of the capacitor bank is progressively reduced to assess the effect on pinch current I_{pinch}. The experiments confirm the I_{pinch}, limitation effect in plasma focus, where there is an optimum L_0 below which although the peak total current, I_{peak}, continues to increase progressively with progressively reduced inductance L_0, the I_{pinch} and consequently the soft X-ray yield, Ysxr, of that plasma focus would not increase, but instead decreases. The obtained results indicate that reducing the present L_0 of the PF-SY2 device will increase the oxygen soft X-ray yield till the maximum value after that the Ysxr will decrease with I_{pinch} decreasing.

Keywords Low energy plasma focus · Soft X-ray · Oxygen gas · Lee Model RADPF5.15 K

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Introduction

The dynamics of plasma focus discharges is complicated; for this purpose, to investigate the plasma focus phenomena, the Lee model couples the electrical circuit with plasma focus dynamics, thermodynamics and radiation, enabling realistic simulation of all gross focus properties.

In the radial phases, axial acceleration and ejection of mass are caused by necking curvatures of the pinching current sheath result in time-dependent strongly center-peaked density distributions. Moreover laboratory measurements show that rapid plasma/current disruptions result in localized regions of high densities and temperatures particularly in the heavy gases like xenon. We need to point out that these center-peaking density effects and localized regions are not modeled in the code, which consequently computes only an average uniform density and an average uniform temperature which are considerably lower than measured peak density and temperature. However, because the 4-model parameters are obtained by