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THE EFFECT OF A COUNTER ELECTRON FLOW ON THE FORMATION AND OPTIMAL ION CURRENT OF A POWERFUL NEUTRAL BEAM INJECTOR *)

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Neutral beam injectors are widely used in thermonuclear research as one of the most effective methods of plasma heating. For positive ion injectors, the operating current density and, accordingly, the injector power is limited by the Child-Langmuir limiting current jch-l, The optimal current density when the beam divergence is minimal determined by a compromise between the focusing geometry of the electrodes and the emission boundary on the one hand and the influence of the space charge on the other. In practice, the operating current density is ~0.7 jch-l. There are known ways to overcome the current limit for a unipolar vacuum diode. Thus, in a bipolar diode with counter ion and electron currents [1], if there is no limit on emission from the cathode and anode, a value exceeding the jch-l by 1.865 times is achieved. Note that a much more effective compensation of the ion space charge is achieved with a powerful bipolar diode with magnetic isolation of electrons, in addition, the electron current is almost completely suppressed, and energy losses on electrons are sharply reduced. In this case the ion current is limited by the achievable magnetic pressure drop between the anode and the cathode [2]. In practice, the ion current can exceed the j_{ch-l} by an order of magnitude or more - see, for example, [3].

This paper describes studies of the injector operation in the mode with a relatively small counter electron beam in the IOS. An injector similar to [4] was used, the beam energy is 15 keV, the current in ions is 150A, and upgraded duration is 0.5-1 s. It is found that the counter electron current 3 times or more higher than the ion one is possible by simply lowering the negative barrier on the suppressing grid of the IOS (or changing its polarity). When the value of the electron current is more than 2-3 times higher than the ion one, the oscillations of the IOS current occurred, leading to breakdowns. It is clear that an unmagnetized electron flow is ineffective for increasing the limiting ion current and at the same time, it increases energy losses many times. Therefore, the change in the dependence of the angular divergence of the beam vs the current was investigated with a slight increase in the electron current of the IOS (up to $\lesssim$ 10÷30% of the ion current), first of all in the area of currents above the optimal. The first experiments show a slowdown in the growth of divergence in this case, i.e. the possibility of a slight ($\lesssim$10%) increase in the operating currents of the injector.

References

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