MAGNETIC CONTROLLED HOLLOW CATHODE ARC DISCHARGE AND ITS APPLICATIONS

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The perspective supply of a “pure” (unalloyed) high-ionized low temperature plasma for different scientific and technical purposes is the hollow cathode arc discharge (HCAD) [1]. For such processes as the compensation of space charge in plasma accele-rators [2], the brazing, the welding and the refining of metals in vacuum (p ≤ 1,33 Pa) [3, 4] are shown themselves to advantage the electric arc devices with a hollow cathode is working with small inert gas flow through the cathode channel. At that the best mode working of cathode (with point of view of its maximum life service) is considered such named “normal” mode which characterizes by the diffuse arc attachment to it and the corresp-onding unmonotonous temperature distribution on cathode surface $T_c(z)$ (v. Fig. 1).

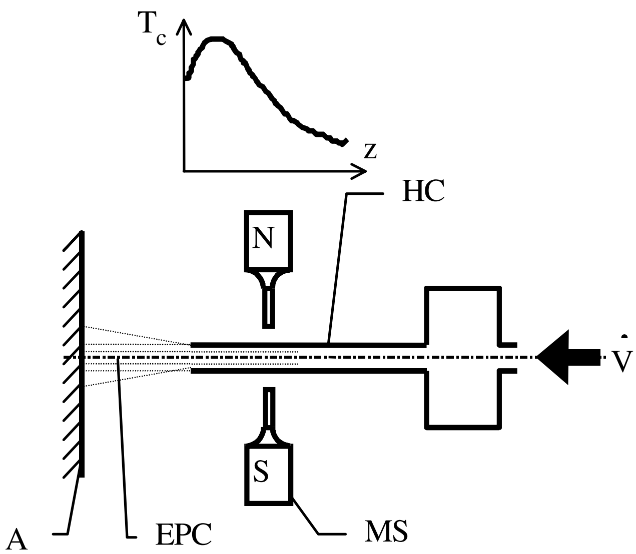

Fig. 1. The hollow cathode arc discharge with inert gas pumping-over: HC - hollow cathode, EPC - external plasma column, A - anode, MS - magnetic system, V - gas flow.

In the course of thorough experimental research of HCAD in “normal” mode with the purpose of its power characteristics we have first discovered essential influence of the external local perpendicular mag-netic field on the arc parameters. That was a beginning of design of the magnetic controlled hollow cathode arc discharge (MCHCAD) concep-tion and of the low temperature plasma functional diagnostics [5].

The effect of these small magnetic fields ($B_{\perp} \leq 30$ mT) to the inside-cathode plasma (v. Fig. 1) results in increasing of the discharge voltage (up to 1,5...2 times) (v. Fig. 2) about a conservation of the initial “normal” cathode mode and a fixed arc current. Besides that was taking place a expansion of the current range of stable arc burning to the small current region (up to 5 A) that, for example, it is very important about brazing and welding of the thin-walled workpieces.

The experiments about probing and spectroscopy of the different discharge parts are confirmed the hollow cathode generation of the high-ionized gas-discharge plasma [6] with a marked part of relatively high-energetic electrons. In a case of MCHCAD plasma characterizes the most values of T_e (v. Fig. 3), that finally results in the rise in the power input to anode (about to 1,5 times) in current stabilization mode (v. Fig. 4).

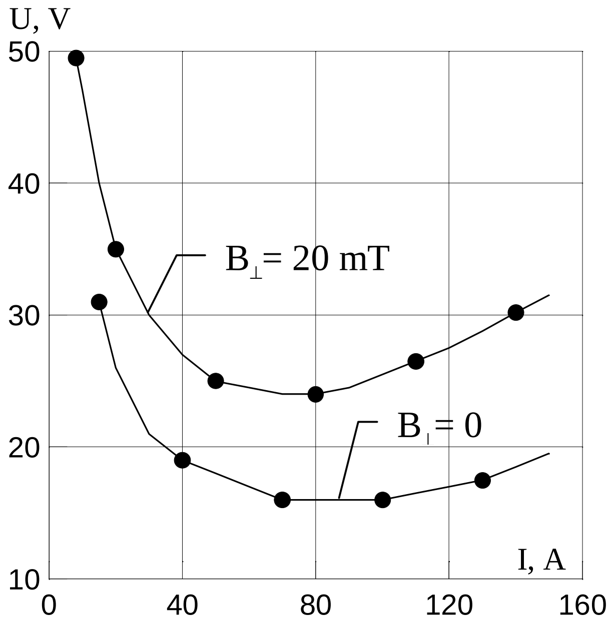

Fig. 2. Volt-ampere characteristics of HCAD: xenon flow of 0,5 cm³/s.

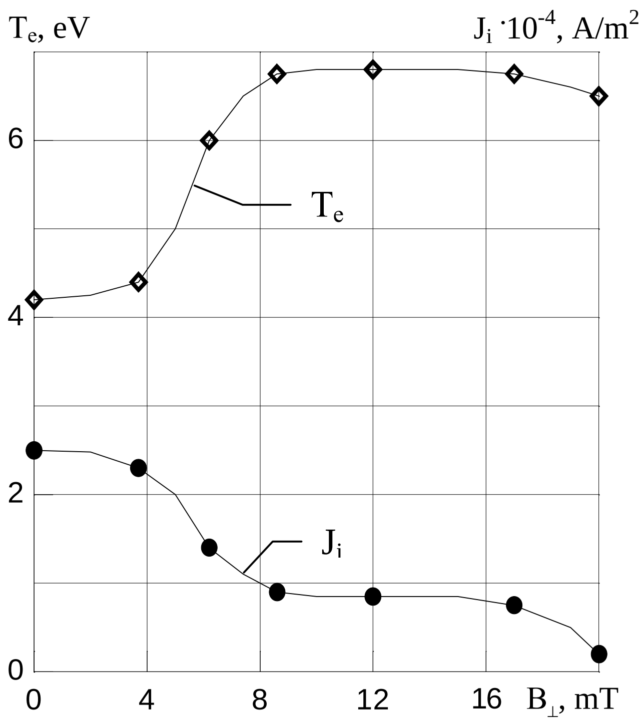

Fig. 3. The changes of plasma parameters of the external discharge column under the perpendicular magnetic field effect.

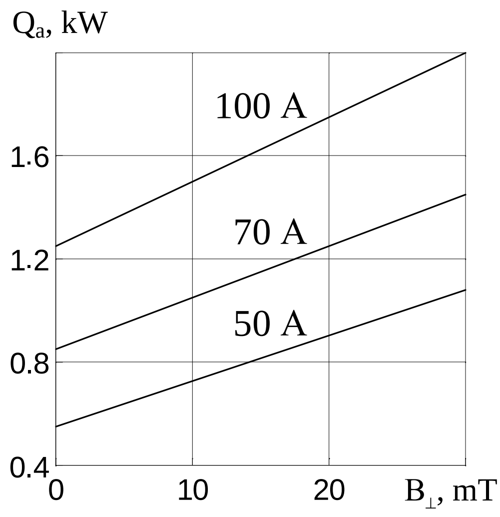

Fig. 4. The heat power input in anode as a function of the magnetic field.

The results of carried out complex research had been a basic for design and creation of the pilots of arc devices intended for universal technology application [7].

In Fig. 5 there is shown the burner with magnetic controlled hollow cathode, rating at the current range of I = 10...300 A about consumed power under 10 kW and is working with the argon flow of v = 0,1...1,0 cm^3/s. This burner is a universal instrument for carrying out the technology operations of welding, brazing and surface heat treatment in vacuum (p≤ 1,33 Pa). The burner is equipped with the special governing generator for supply of the control magnetic system. It permits to change the arc current within the limits of (0,5...1,0)I about the given temporal law and to realize the arc column scanning of a worked surface with the amplitude up to 50 mm and the frequency of 1...10 Hz.

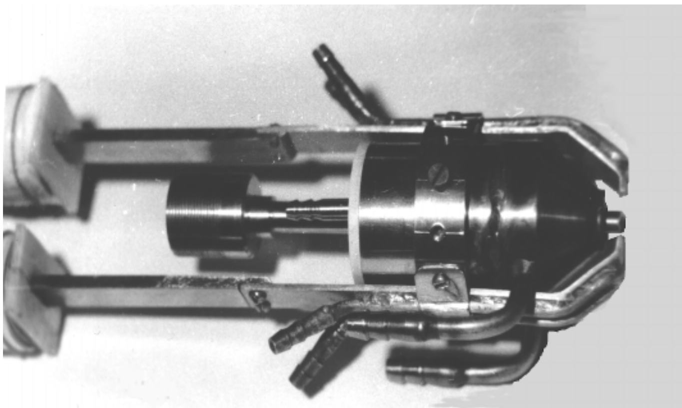

Fig. 5. The burner with the magnetic controlled hollow cathode.

This burner successfully underwent operational tests under conditions of the welding technology processes of the complex form workpieces from titanium alloys with a wall thickness up to 14 mm.

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