PACS: 41.75Fr, 52.40 Mj

Estimation of characteristics of plasma created by electron beam generator with rare gas blown through the discharge gap

A. I. Shloydo and A. V. Turkin

Joint-Stock Company State Scientific Center of the Russian Federation "Keldysh Research Center"
(JSC Keldysh Research Centre)
8 Onezhskaya st., Moscow, 125438, Russia
E-mail: blackash@aha.ru

Received 27.06.2023; revised 12.07.2023; accepted 20.07.2023

The calculated and experimental technique of estimation of plasma characteristics has proposed. The power of electron beam and electrons mean path could be found on current-voltage characteristics and the energetic efficiency of electron beam generators. Ionization yield of gases mixture could be found in assumption about equality processes of ionization and recombination of charge particles. It has been shown that in the plasma which produced by electron beam generators in gases mixture with medium pressure key role is playing the process of dissociative recombination. Using measured current-voltage characteristics calculation of plasma characteristics in gases mixture (oxygen 20.9 %, nitrogen – 78.1 %, water vapor 1 %) at a pressure from 1 to 2,5 kPa has done.

Keywords: electron beam generators, plasma characteristics, plasma of medium-pressure gases, electron concentration.

DOI: 10.51368/2307-4469-2023-11-4-300-311

REFERENCES

1. Polak L. S., Ovsyannikov A. A., Slovetskii D. I. and Vurzel' F. B., Teoreticheskaya i prikladnaya plazmokhimiya (Theoretical and Applied Plasma Chemistry), Moscow, Nauka, 1975 [in Russian].

2. Zav'yalov M. A., Kreindel' Yu. E. and Novikov A. A., Plasma Processes in Technological Electron Guns, Moscow, Energoatomizdat, 1989 [in Russian].

3. Panchenko A. N., Sorokin D. A. and Tarasenko V. F., Progress in Quantum Electronics **76**, 100314 (2021). doi: 10.1016/j.pquantelec.2020.100314.
EDN PXCRFR.

4. Bokhan P. A., Gugin P. P., Lavrukhin M. A., Glubokov N. and Zakrevsky D. E., Phys. Plasmas **30**, 043504 (2023). doi: 10.1063/5.0138062.

5. Bobrov V. A., Voiteshonok V. S., Golovin A. I., Golubev M. M., Turkin A. V. and Shloydo A. I. Electron beam generation. Patent for invention № 2535622 (RF). 2014. EDN ZFSYOL.

6. Voiteshonok V. S., Golovin A. I., Turkin A. V. and Shloydo A. I., J. Phys.: Conf. Ser. **1109**, 012030 (2018). doi: 10.1088/1742-6596/1109/1/012030.
EDN NWISNY.

7. Shloydo A. I., Turkin A. V., Voiteshonok V. S. and Egorova E. K., J. Phys.: Conf. Ser. 012009 (2021).
doi: 10.1088/1742-6596/2055/1/012009. EDN NWEZJK.

8. Tarasenko V. F., Runaway Electrons Preionized Diffuse Discharges, NY, Nova Science Publishers, 2014.

9. Chanrion O., Neubert T., Mogensen A., Yair Y., Stendel M., Singh R. and Siingh D., Geophys. Res. Lett. **44**, 496–503 (2017). doi: 10.1002/2016GL071311.

10. Vlainic M., Ficker O., Mlynar J. and Macusova E., Atoms. **7**, 1–12 (2019).
doi: 10.3390/atoms7010012

11. Hender T et al., Nucl. Fusion. **47**, S128 (2007). doi: 10.1088/0029-5515/47/6/S03

12. Kuteev B. V. and Kostryukov A. Y., Technical Physics Letters **25** (15), 33–40 (1999) [in Russian].
EDN RGPSYT.

13. Paschen F., Annalen der Physik. **273** (5), 69–75 (1889). doi: 10.1002/andp.18892730505.

14. Raizer Yu. P., Gas Discharge Physics, Dolgoprudnyj, Intellekt, 2009 [in Russian].

15. Kudryavtsev A. A., Smirnov A. S. and Tsendin L. D., Physics of Glow Discharge, St. Petersburg, Lan', 2010 [in Russian].

16. Mott-Smith H. M. Langmuir Irving, Phys. Rev. **28** (4), 727–763 (1926). doi: 10.1103/PhysRev.28.727.

17. Huddlestone R. H. and Leonard S. L., Plasma Diagnostic Techniques, New York, Academic, 1965.

18. Aleksandrov N. L., Anokhin E. M., Kindysheva S. V. et al., Plasma Physics Reports **38** (2), 179–186

(2012). doi: 10.1134/S1063780X12010011.
EDN PDKLGT.

19. Kudryavcev A. A., Morin A. V. and Mustafaev A. S. Proc. XXXIV Conference on plasma physics and controlled fusion, Zvenigorod, 2007.

20. Golovin A. I., High Temperature **49** (3), 456–459 (2011). doi: 10.1134/S0018151X11030072.
EDN OHQSWH.

21. Ginzburg V. L., Rasprostranenie Elektromagnitnykh Voln v Plazme 2-e izd., Moscow, Nauka, 1967 [in Russian].

22. Arlantsev S. V., Borovich B. L., Buchanov V. V., Molodykh E. I. and Yurchenko N. I., J Russ Laser Res. **16** (2), 99–119 (1995). doi: 10.1007/BF02580863.
EDN ZYGXDX.

23. Voiteshonok V. S., Golovin A. I., Shloydo A. I. et al., High Temperature **55** (5), 665–671 (2017).
doi: 10.1134/S0018151X17050194. EDN XOFVJB.

24. Grigoriev I. S. and Meilikhov E. Z. (Eds) Handbook of Physical Quantities, Boca Raton, NY, CRC Press, 1996.

25. Golovin A. I., Applied Physics, № 5, 54–58 (2015) [in Russian]. EDN UXOWBJ.

26. Kanaya K. A. and Okayama S., Journal of Physics D: Applied Physics **5** (1), 43 (1972).
doi: 10.1088/0022-3727/5/1/308.

27. Baranov V. F., Dosimetry of Electron Radiation, Moscow, Atomizdat, 1974 [in Russian].

28. Voiteshonok V. S., Golovin A. I., Turkin A. V. and Shloydo A. I., J. Phys.: Conf. Ser. **927**, 012073 (2017). doi: 10.1088/1742-6596/927/1/012073. EDN XXQTDV.

29. Kvitov S. V., Lomakin B. N., Solov'ev V. R., Sunarchin A. A., Tikhonov M. G. and Cherkasskii N. V., Plasma Physics Reports **22** (12), 1032–1043 (1996).
EDN KAMZXB.

30. Mätzing H., Chemical kinetics of the flue gas cleaning by electron beam, Karsruhe, KFK 4494, 1989.

31. Bychkov V. L. and Yurovskij V. A., Teplofizika vysokikh temperatur **31** (1), 8–17 (1993). EDN KSPWBN.

32. Chanin L. M., Phelps A. V. and Biondi M. A., Physical Review. **128**, 219 (1962).
doi: 10.1103/PhysRev.128.219.

33. Hurst G. S. and Bortner T. E., Physical Review. **114**, 116 (1959). doi: 10.1103/PhysRev.114.116.

34. Popov M. A., Anokhin E. M., Kochetov I. V. et al., Plasma Phys. Rep. **47**, 742–751 (2021).
doi: 10.1134/S1063780X21070138

35. Aleksandrov N. L. et al., J. Phys. D: Appl. Phys. **55**, 383002 (2022). doi: 10.1088/1361-6463/ac7d7c

36. Lojcyanskij L. G., Mexanika zhidkosti i gaza (Liquid and gase mechanics), Moscow, Drofa, 2003 [in Russian].

37. Lyu X., Yuan C., Avtaeva S. V. et al., Plasma Phys. Rep. **47** (4), 369–376 (2021).
doi 10.1134/S1063780X21040061. EDN FGSVFA.

38. Golovin A. I., Golubev M. M., Egorova E. K. et al., Technical Physics **59** (5), 670–674 (2014).
doi: 10.1134/S1063784214050089. EDN SOSQFX.

39. Zhao S., Lyu X., Liu Y., Yuan C., Avtaeva S., Kudryavtsev A. and Zhao Z., IEEE Access. (11) pp. 19339–19346 (2023). doi: 10.1109/ACCESS.2023.3248072