

DOI: <https://doi.org/10.15407/techned2018.02.003>

**CYCLIC TRANSIENTS IN THE CIRCUITS OF ELECTRIC DISCHARGE INSTALLATIONS
TAKING INTO ACCOUNT THE INFLUENCE OF MAGNITUDE AND RATE OF DISCHARGE
CURRENTS RISE ON RESISTANCE OF ELECTRIC SPARK LOAD**

Journal	Tekhnichna elektrodynamika
Publisher	Institute of Electrodynamics National Academy of Science of Ukraine
ISSN	1607-7970 (print), 2218-1903 (online)
Issue	No 2, 2018 (March/April)
Pages	3 – 10

Authors

A.A. Shcherba*, N.I. Suprunovska**

Institute of Electrodynamics National Academy of Sciences of Ukraine,
pr. Peremohy, 56, Kyiv, 03057, Ukraine,
e-mail: iednat1@gmail.com

* ORCID ID : <http://orcid.org/0000-0002-0200-369X>

** ORCID ID : <http://orcid.org/0000-0001-7499-9142>

Abstract

The cyclic transients in the charge-discharge circuits of capacitor of semiconductor electrical discharge installation using the mathematical model of resistance of the electrical spark load, which depends on magnitude of discharge current, rate of its change and duration of the time pause between discharge pulses are studied. The mathematical model reflects the U-shaped character of the change in the resistance of such load in time (in particular, in the case of volumetric electro-spark dispersion of a layer of current-conductive granules in a dielectric

liquid). Also this model takes into account that the load resistance can have different values at the beginning and end of the discharge process of the capacitor and varies during the pause between the discharge pulses. A comparison of the transient results (discharge pulse duration, released in the load energy, average pulse power and rate of current rise in the load) in the discharge circuits with a nonlinear resistance of spark load and the energy-equivalent linear resistance is made. The analysis of ways to improve the dynamic characteristics of pulse currents in the load in the case of control of capacitor discharge duration is carried out. References 17, figures 4, tables 2.

Key words: nonlinear resistance, electric spark load, pulse, transients, mathematical model.

Received: 20.09.2017

Accepted: 09.10.2017

Published: 01.03.2018

References

1. Vovchenko A.I., Tertilov R.V. Synthesis of capacitive non-linear- parametrical energy sources for discharge-pulse technologies. *Zbirnyk naukovykh prats Natsionalnoho universytetu korablebuduvannia. Mykolaiv, 2010. No 4. Pp*

. 118–124.

(Rus)

2. Volkov I.V., Vakulenko V.M. Sources for power supply of lasers. Kyiv: Tekhnika, 1976. 176 p

.
(Rus)

3. Petrichenko S.V. Dynamics of spark-erosion processes during discharge in current-conducting granular layer. Proc. 11th International Conference on *Physics of Impulse Processes in Condensed Media*

. Mykolaiv. Ukraine, 22-26 August 2003. Pp. 42–43. (Rus)

4. Shcherba A.A., Suprunovska N.I., Ivashchenko D.S. Modeling of nonlinear resistance of electro-spark load taking in to account its changes during discharge current flowing in the load and at zero current in it . *Tekhnichna*

Elektrodynamika

.
201

4

.
No

5

.
Pp

.
2

3

—

25. (Rus)

5. Shcherba A.A., Shtompel I.V. Analysis electrical parameters and dynamics of spark discharges in a layer of current-conducting granules. Stabilizatsiia parametrov elektricheskoi energii. Kiev: IED AN Ukrainy, 1991. Pp. 65–74. (Rus)

6. Zakharchenko S.N., Kondratenko I.P., Perekos A.Ye., Zalytsky V.P., Kozyrsky V.V., Lopat'ko

K.G. Influence of duration of discharge pulses in a layer of iron granules on the sizes and a structurally-phase state of its electro-eroded particles. *Vostochno-Evropeiskii Zhurnal peredovykh tekhnologii* . 2012. Vol. 6. N 5 (60).
Pp . 66–72.
(Rus)

7. Shcherba A.A. Principles of construction and parameters stabilization of semi-conductor electro-pulse systems for electro-spark dispersion of current-conducting materials layer. *Stabilizatsiia parametrov elektricheskoi energii*. Kiev : IED AN Ukrainy , 1991.
Pp . 12 – 30.
(Rus)

8. Suprunovska N.I., Shcherba A.A. Regularity of change of the energy loss in RL – circuits connecting capacitors, charged to different voltage. *Tekhnichna elektrodynamika* . 2015 . No 6.
Pp . 3–7. (Rus)

9. Suprunovska N.I., Shcherba A.A., Ivashchenko D.S., Beletsky O.A. Processes of energy

exchange between nonlinear
and linear links of
electric equivalent circuit
of supercapacitors.

Tekhnichna Elektrodynamika

.

201

5

.

No 5

.

Pp

.

3

—

11

. (Rus)

10. Berkowitz A.E., Walter J.L. Spark Erosion: A Method for Producing Rapidly Quenched Fine powders. *J. of Mater. Res.* 1987. March/April. 2 (2). Pp. 277–288.

11. Sen B., Kiyawat N., Singh P.K., Mitra S., Ye J.H., Purkait P. [Developments in electric power supply configurations for electrical-discharge-machining \(EDM\)](#)

.

The 5th International Conference on
Power Electronics and Drive Systems

(PEDS). Singapore, 17-20 November 2003. Vol. 1. Pp. 659 – 664.

12. Carrey J., Radousky H.B., Berkowitz A.E. Spark-eroded particles: Influence of processing parameters. *Journal of Applied Physics*. 2004.

Vol. 95. No 3. Pp. 823–829.

<https://doi.org/10.1063/1.1635973>

13. Casanueva R., Azcondo F.J., Branas C., Bracho S. Analysis, design and experimental results of a high-frequency power supply for spark erosion.

IEEE Transactions on Power Electronics

. 2005. Vol. 20. Pp. 361 – 369.

<https://doi.org/10.1109/TPEL.2004.842992>

14. Berkowitz A.E., Hansen M.F., Parker F.T., Vecchio K.S., Spada F.E., Lavernia E.J., Rodriguez R. Amorphous soft magnetic particles produced by spark erosion. *J. of Magnetism and Magnetic Materials*. 2003. January. Vol. 254–255. Pp. 1–6.

15. Nguyen, P.-K., Sungho J., Berkowitz A.E. MnBi particles with high energy density made by spark erosion. *Journal of Applied Physics*. 2014. Vol. 115. Iss. 17. Pp. 17A756-1.

16. Nguyen P.K., Lee K.H., Moon J., Kim K.A., Ahn K.A., Chen L.H., Lee S.M., Chen R.K., Jin S. and Berkowitz A.E. Spark erosion: a high production rate method for producing Bi_{0.5}Sb_{1.5}Te₃ nanoparticles with enhanced thermoelectric performance. *Nanotechnology*. 2012. No 23. Pp. 1–7.
<https://doi.org/10.1088/0957-4484/23/41/415604>

17. Kokorin V.V., Perekos A.O., Tshcherba A.A., Babiy O.M., Efimova T.V. Intermartensitic phase transitions in Ni-Mn-Ga alloy, magnetic field effect. *Journal of Magnetism and Magnetic Materials*. 2006. Vol. 302. Iss. 1. Pp. 34–39.
<https://doi.org/10.1016/j.jmmm.2005.08.010>

[PDF](#)