EXPERIMENTAL STUDY OF THE EFFECT OF WALL TEMPERATURE ON THE AXIAL TEMPERATURE OF AN ELECTRIC ARC

R. E. Krzhizhanovskii and I. D. Skuratova

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The temperature at the axis of a light-current electric arc has been investigated at different wall temperatures. The results are presented below.

Recently, considerable interest has been expressed in light-current arcs, which form a useful tool for studying the physical processes of arc burning.

So far, almost no attention has been paid to the question of the effect of removal of heat from the arc on its axial temperature and the radial temperature distribution [1].

Accordingly, the Central Boiler-Turbine Institute has made an experimental study of the nature and relative influence of the wall temperature of a light-current arc on its axial temperature. In all these experiments the axial temperature was measured from the intensity of cyanogen bands with an unresolved rotational structure. This method of determining temperature was developed by the Ornshtein school [2,3]. In the spectrum of an ordinary carbon arc burning in air we get the following band systems: violet (4216–4197–4181, 3883–3872–3862, 3590–3586–3584) and red (9168). In [4] graphs are given for determining the temperature from the intensity ratio of the CN band maxima: 3883 and 3872, 4216 and 4197.

Using these graphs, we obtained the axial temperature of the arc in all the cases investigated.

The object of investigation was air, the electrodes were carbon, 6 mm in diameter. All the experiments employed 10 amp dc. To exclude the influence of heat exchange between arc and electrodes on the axial temperature, the interelectrode gap was made quite large (about 60–80 mm).

The arc spectrum was obtained with a ISP-28 spectrograph; the spectrum was analyzed with a DSP-1 spectrum projector and a MF-1 microphotometer. The degree of cooling of the outside layers of the arc discharge was determined from the experimental conditions. There were three kinds of experiments: "free" arc, arc in a water-cooled copper cylinder, and arc in a quartz tube. The inside diameter of the copper and quartz tubes was 20 mm.

To obtain the starting data, we determined the axial temperature of the free arc and obtained information on its stability with respect to time. As may be seen from the figure, with a certain inevitable scatter the axial temperature remains constant during the entire test period.

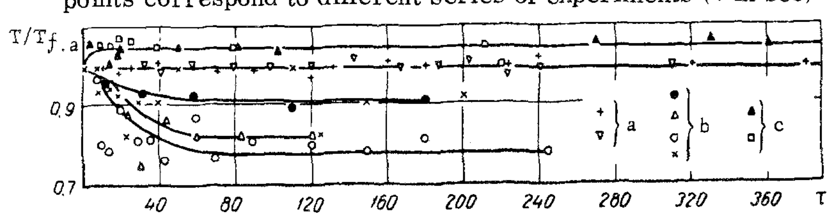
The order of carrying out the tube experiments was as follows: first we struck a free arc at a current of 10 amp and determined the axial temperature; then we rapidly introduced the tube into the arc zone from above and began to measure the variation of the temperature with time.

The results are presented in the figure. The general tendency is for the axial temperature of an arc stabilized with a copper water-cooled tube to be somewhat higher than that of the free arc. Introducing a quartz tube (which was heated to about 1600° K) reduces the axial temperature of the arc. The direction of the effect on axial temperature of cold and hot walls may be explained as follows: when the arc is specially cooled the radius of the conducting column decreases and (at the same current) the axial temperature must increase. Our temperature distribution experiments confirmed this. For the experiments with quartz tubes the temperature distributions obtained give a much fuller profile than for a free arc.

We note also that the scatter of the data for an arc stabilized with a cold tube is much less than for a quartz tube. This is because of the visibly greater stability of the arc in the water-cooled tube.

As the figure shows, the effect of a heated quartz tube is quite marked, requiring further study. Making the corresponding calculations for the investigated arc proved to be still impossible owing to lack of data on its radiation power.

Variation of axial temperature in: a) free arc; b) arc in quartz tube and; c) arc in water-cooled copper tube. The different points correspond to different series of experiments (τ in sec).



REFERENCES

1. W. Finkelnburg and H. Maecker, Electric Arcs and Thermal Plasma [Russian translation], 1961.
2. M. M. Smit-Missen and J. L. Spier, Physica, 9, 193, 422, 1942.
3. J. A. Smit, Physica, 12, 683, 1946.
4. Collection: Optical Plasma Pyrometry [in Russian], ed. N. N. Sobolev, 1960.

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Polzunov Central Boiler-Turbine Institute, Leningrad