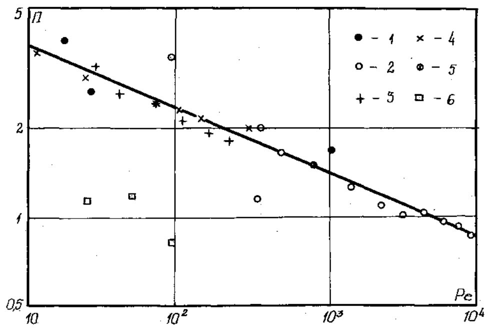

Fig. 1 Dependence of the number Π upon Peclet number: 1—argon, $P = 0.66 \cdot 10^5\ N/m^2$, $d = 5$ mm: 2—argon, $P = 0.13 \cdot 10^5\ N/m^2$, $d = 10$ mm: 3—helium, $P = 0.395 \cdot 10^5\ N/m^2$, $d = 5$ mm: 4—helium, $P = 0.263 \cdot 10^5\ N/m^2$, $d = 10$ mm: 5—hydrogen, $P = 4.6 \cdot 10^3\ N/m^2$, $d = 10$ mm: 6—nitrogen, $P = 6.5 \cdot 10^3$ and $0.12 \cdot 10^5\ N/m^2$: $d = 5$ mm and $d = 10$ mm.

in the direction opposite to gas motion. In addition, in this case local pressures may essentially increase and physical plasma properties may vary. The generalized curve $\Pi = f(\text{Pe})$ may be approximated by the expression

$$\Pi = 6.03\,(\text{Pe})^{-0.21} \tag{1}$$

References

[1] Wutzke, S. A., Pfender, E., and Eckert, E. R. G., "Symptomatic Behavior of an Electric Arc with a Superimposed Flow," *AIAA Journal*, Vol. 6, No. 8, 1968, p. 1474.

[2] Yasko, O. I., "Correlation of the Characteristic of Electric Arcs," *British Journal of Applied Physics*, 1969, Ser. 2, Vol. 2, pp. 733–751.

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Reply by Authors to O. I. Yasko

S. A. Wutzke,* E. Pfender,† and E. R. G. Eckert‡
University of Minnesota, Minneapolis, Minn.

YASKO presents in his discussion the results of Ref. 1 in a dimensionless form. This is generally desirable in continuum mechanics but the authors feel that a few comments are in order regarding its use in the present situation.

Yasko implies that in Ref. 1 the Reynolds number was considered as the only important dimensionless parameter. Actually Figs. 4 and 5 were presented in support of the conclusion that for a specific gas and a constant electric current the Reynolds number correlates the data satisfactorily. The influence of the electric current was demonstrated in Fig. 6. We are, therefore, in agreement with Yasko that the electric current in addition to the Reynolds number influences the flow and energy processes and, therefore, also the restrike behavior of an arc.

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* Engineering Plasma Programs, Research and Development Center, Westinghouse, Churchill, Pittsburgh, Pa. Member AIAA.
† Professor, Heat Transfer Division, Department of Mechanical Engineering. Member AIAA.
‡ Regents Professor and Director, Thermodynamics and Heat Transfer, Department of Mechanical Engineering. Fellow AIAA.

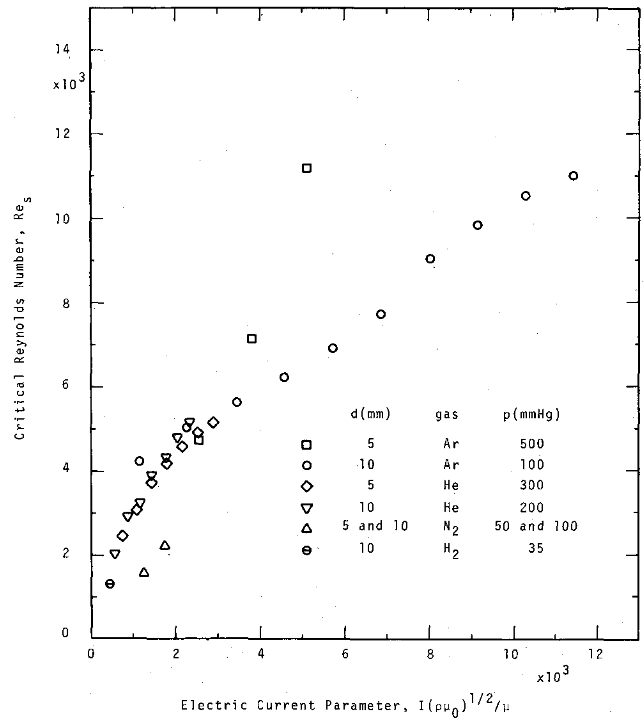

Fig. 1 Dependence of critical Reynolds number on electric current parameter (double anode configuration).

The main advantage obtained by a dimensionless presentation of experimental results lies in the possibility to generalize them. The dimensionless parameters which prescribe the process have then to be based on the boundary conditions or in experimental terms on those physical quantities which can be changed at the desire of the experimenter. In the present situation the following quantities are of this nature: the scale of the experimental setup described by a selected length S, the upstream velocity V, pressure p, and temperature T of the gas as well as its nature (because it determines the way in which the thermodynamic and transport properties involved change with the thermodynamic state) and the magnitude I of the electric current. The following dimensionless parameters can be obtained from the conservation equations: a Reynolds number, $Re = \rho VS/\mu$, a Prandtl number Pr and a parameter $J = I(\rho\mu_0)^{1/2}/\mu$ (the nomenclature is the same as in the paper) which appears more convenient to use than the parameter π in Yasko's discussion because it contains physical properties only in addition to the electric current. The Prandtl number was not varied over a sufficiently large range to establish its influence. The parameters listed above would completely describe the behavior of the arc if the physical properties involved could be considered as constant. In reality, however, they vary considerably and it must be left to experience whether a presentation of test results with these parameters is satisfactory. We have, therefore, replotted the data from Fig. 6 of Ref. 1 in Fig. 1 of this reply. It may be observed that the use of the parameter J instead of the electric current I somewhat improves the correlation.

Dimensionless analysis has the disadvantage that it does not give any information on the details of the physical processes involved. These can be obtained by detailed experimentation or analysis only and the second part of Ref. 1 proposes an analysis based on a model which describes the essential physical processes.

Reference

[1] Wutze, S. A., Pfender, E., and Eckert, E. R. G., "Symptomatic Behavior of an Electric Arc with a Superimposed Flow," *AIAA Journal*, Vol. 6, No. 8, August 1968, p. 1474.