# CONCERNING M. E. DEICH AND A. E. ZARYANKIN'S BOOK "GAS DYNAMICS OF DIFFUSERS AND EXHAUST PIPES OF TURBOMACHINES"

A. S. Ginevskii

In connection with the publication of M. E. Deich and A. E. Zaryankin's book "Gas Dynamics of Diffusers and Exhaust Pipes of Turbomachines" ("Energiya," Moscow, 1970) I consider it necessary to note the following. In the Preface the authors "express sincere thanks" to a group of persons (including me) "whose comments influenced considerably the final version of the book." The reader, naturally, gets the impression that all these persons familiarized themselves closely with the manuscript of the book and bear to some extent a moral responsibility for its scientific level.

As concerns me, I did not read the manuscript of the second version of this book. In 1964 the authors presented the first version of the book with a volume of 15 sheets to the publishing house "Mashinostroenie." I was one of its reviewers. The reviewers found that the initial formulas contained in the book for calculating hydraulic losses were incorrect, in connection with this doubt was expressed concerning the soundness of the experiments, which agreed well with the calculations by the erroneous formula. The publishing house "Mashinostroenie" returned the book to the authors.

Unfortunately, the new version of the book (with a volume of about 22 sheets) also contains errors of a fundamental character. We will indicate as an example several such errors in the part of the book written by A. E. Zaryankin.

1. In the book the expression for the coefficient of total pressure losses in the initial section of the diffuser is derived by two methods. The difference between them consists in that the coefficient of losses is expressed by integral characteristics of the boundary layer in the extreme cross section of the diffuser; the second method is incorrect in principle, and therefore it is not surprising that it leads to an erroneous result. According to this derivation, the coefficient of losses is determined by two cofactors, of which the first represents the correct expression for the coefficient of losses and the second an integral of the form

$$A=\int_0^1 \frac{\rho}{\rho_2}\left(\frac{c}{c_2}\right)^3 d\left(\frac{\delta^{***}}{\delta_2^{***}}\right).$$

Then from the conditions of agreement of both formulas the author arrives at the conclusion that the integral presented above should be equal to unity, i.e., $A = 1$ (Eq. (2.54) on page 81). Here $\rho$ and c are respectively the gas density and velocity in the flow core; $\delta^{***}$ is the energy thickness; the subscript 2 pertains to the exit section of the diffuser. The author states (page 81) that "...with a correctly calculated boundary layer Eq. (2.54) should become an identity. Hence follows the opposite, rather attractive prospect: to use Eq. (2.54) for calculating the boundary layer."

Here the author allows an elementary mathematical error. Integral (2.54) becomes an identity in the sole case when $\rho c^3 = \text{const} = \rho_2 c_2^3$ and consequently cannot be used for calculating the boundary layer in diffusers. If we take into account that integral (2.54) is not equal to unity, the losses in the diffuser prove to be dependent not only on the parameters of the boundary layer in its extreme sections but also on the law of variation of these parameters in its intermediate sections. This error of the author was noted in the abstracts journal "Mekhanika" (4B184, 1963) and then criticized in Inzhenerno-Fizicheskii Zhurnal, No. 4, 1965.

Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 20, No. 6, pp. 1119-1120, June, 1971.

Unfortunately, the "attractive prospect" of the wide use of fundamentally erroneous Eq. (2.54) for calculating the boundary layer in diffusers is realized in the book. As the author states (see, for example, pages 138 and 277), such a calculation agrees completely satisfactorily with the experimental data for diffusers with large values of the degree of expansion n, up to n = 6. The statement on page 277 that the author takes into account the "certain controversial character of Eq. (2.54)" does not save the situation.

2. The author attempted to calculate the total pressure losses in a diffuser with closed boundary layers when the potential core of the flow is absent and the Bernoulli equation cannot be used for determining the pressure. Without sufficient grounds it is recommended in the book to use for this purpose the corresponding equation for the initial section of the diffuser with the only difference being that some conditional velocity rather than the velocity on the channel axis is used as the characteristic velocity in calculating the integral boundary-layer thicknesses. The equation thus obtained does not reduce to the correct equation contained in my and A. V. Kolesnikov's article published in Izvestiya Akademii Nauk SSSR, Mekhanika Zhidkosti i Gazy, No. 6, 1969.

3. When calculating the boundary layer in a diffuser when the potential core of the flow is absent it is necessary to take into account in the integral relation of momenta, as is known, an additional term of the form

$$\delta\left(c\frac{dc}{dx}+\frac{1}{\rho}\cdot\frac{dp}{dx}\right)\left(\frac{r_w}{2}\right)^j .$$

Here $\delta$ is the boundary-layer thickness; $r_W$ is the radius of the cross section of a circular channel ($r_W = \delta$); j = 0 and 1 for a plane and axisymmetrical channel, respectively. Unfortunately, the author does not take into account this term.

The list of erroneous equations, careless reasoning, and vague formulations can be continued.

The wide use in the book of methods of boundary-layer theory for constructing engineering methods of calculating the efficiency of diffuser channels ought to be applauded. However, the serious errors noted above in many respects reduce the value of the book which can confuse readers and discredit the use of methods of boundary-layer theory for calculating diffuser channels. This is why I consider that the publishing house "Energiya" rendered a disservice to the authors and readers of the book by publishing it in such an unprepared form.