Modified Oseen's Equation for a Flow Past a Semi-infinite Plate

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By Jun-ichi OKABE

In an elegant paper recently published Prof. Howarth succeeded in obtaining the exact solution of the Rayleigh's problem for a semi-infinite plate coincident with the half plane $y = 0$, $x \geqq 0$.[1] Moreover, as he noticed, if we replace t (time) by z/W, we should expect to form a qualitative picture of the flow with velocity W past the quarter plane $y = 0$, $x \geqq 0$, $z \geqq 0$, whose leading edge is normal to the incident flow. However, the result of this substitution is so-called Oseen's linearized theory of the flow and as is well-known the approximation is not satisfactory for high Reynolds' numbers.

A few years ago in a joint paper Prof. Yamada and the present writer proposed a modification of Oseen's method;[2] namely multiplying the general flow in the equation by n^2, a constant, they could obtain a good approximation for the general behavior of the two-dimensional laminar boundary layer of an infinite flat plate. The value of n^2 was found to be $\sqrt{2} - 1 = 0.414\cdots$ (n_1) when the over-all agreement of the velocity profile with Blasius' solution is desired, while $n^2 = 0.346\cdots$ (n_2) when the agreement is necessary with respect to the skin friction. In the figure these velocity profiles are reproduced from the original paper. The same modification will be useful for the problem of a semi-infinite plate and the appropriate value of n may be possibly not far from the values above-mentioned.

In particular, the present writer who is interested in the problem of the boundary layer of a semi-infinite plate feels it convenient to insert here for our future reference the result of the modification of Table I (Howarth, *loc. cit.*) where the calculated numerical data of the skin friction are shown. In terms of the same notations as in the original paper and making use of n_2 mentioned above, the following result is obtained.

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1) L. Howarth, Rayleigh's Problem for a Semi-infinite Plate, *Proc. Cambridge Phil. Soc.*, 46 (1950).

2) H. Yamada and J. Okabe, An Approximate Calculation of the Laminar Wake Behind a Flat Plate, *Rep. Res. Inst. for Fluid Engg.*, vol. 4, No. 1 (1947).

$\sqrt{\frac{W}{\nu z}}\,x$		$\sqrt{\frac{W z}{\nu}}\,\frac{\tau}{\rho W^2}$	
Howarth	Modified	Howarth	Modified
0.01	0.017	4.620	2.719
0.05	0.085	2.094	1.232
0.10	0.170	1.506	0.886
0.20	0.340	1.101	0.648
0.40	0.680	0.831	0.489
0.60	1.019	0.723	0.426
0.80	1.359	0.665	0.391
1.0	1.699	0.630	0.371
1.2	2.039	0.608	0.358
1.4	2.379	0.584	0.344
1.6	2.718	0.577	0.340
1.8	3.058	0.573	0.337
2.0	3.398	0.570	0.335
2.5	4.248	0.567	0.334
3.0	5.097	0.565	0.333
3.5	5.947	0.565	0.333
4.0	6.796	0.564	0.332
∞	∞	0.564	0.332

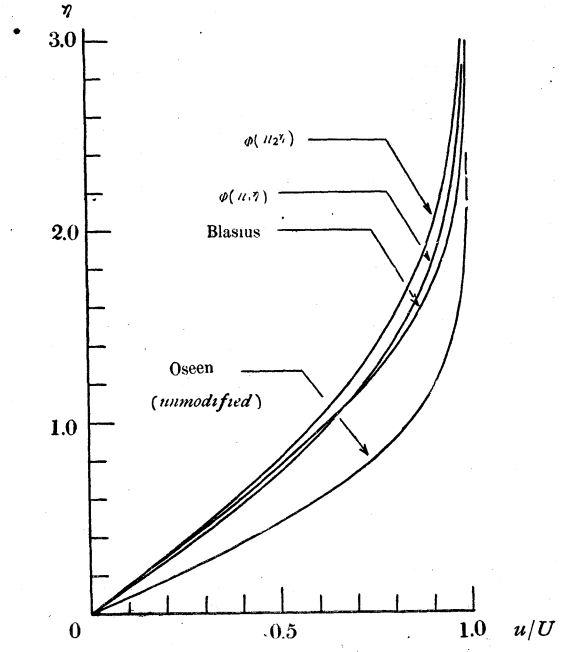

Fig. 1

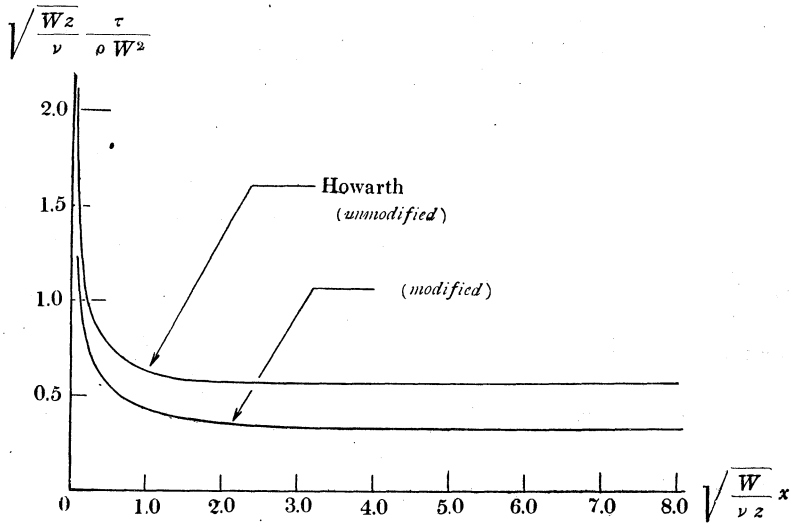

Fig. 2

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ERRATA

On the Forms of Hen's Eggs

By Jun-ichi OKABE

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Page 18, line 16 from the bottom, for "cource" read "course."

Page 19, line 6 from the bottom, for "permenent" read "permanent."

Page 27, (5.2),

for "$\left\{1+\omega\left(f+\frac{1}{4}g\right)\right.$" read "$\left\{1+\omega\left(f+\frac{1}{4}g\right)\right\}$."

Page 27, line 11 from the bottom, for "right hand" read "right-hand."