Reply by the Author to M. Mokry

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I WOULD like to thank Dr. Mokry for his insightful contribution to the discussion of residual drag correction, particularly his description of the flow physics. The assumption in his analysis of stagnant flow within the model/wake body retains the essential features yet avoids treating the source singularity and its added mass flow. However, Mokry's assertion that the residual drag of Eq. (6) does not include drag due to gradient effects at the model deserves reply. His definition of a control volume using far upstream and far downstream planes, together with parallel tunnel walls, implicitly includes all of the residual forces that act on the model, whatever their cause. Gradient effects, therefore, are not excluded by his analysis. The singularity treatment of Ref. 1 gives the same result but also shows explicitly how "cross" effects between solid and wake terms cancel at the model. Reference 1 demonstrates this only for a simple source–source–sink system, but it should be noted that this result can be generalized to an arbitrary number of sources and sinks within the test section.

A further point concerns Mokry's assumption, following Eq. (4), that the wake area is small compared with the tunnel area. This assumption is unnecessary. The analysis given by Prandtl and Tietjens[2] closely parallels Mokry's and gives the same result, in another notation, without this approximation. This is achieved by expressing the tunnel mass flow, in Mokry's Eq. (3), as $C\rho U_1$ rather than $(C - Q)\rho U_2$.

In view of this, it remains the author's view that the result expressed by Mokry as Eq. (6) does include gradient effects at the model, and it is not limited to small wakes.

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References

[1]Hackett, J. E., "Tunnel-Induced Gradients and Their Effect on Drag," *AIAA Journal*, Vol. 34, No. 12, 1996, pp. 2575–2581.

[2]Prandtl, L., and Tietjens, O. G., *Applied Hydrodynamics*, Dover, New York, 1957, Article 78, p. 118.

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