Reply

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The first difficulty mentioned by Acheson (1988) is definitely a problem. After recognizing that cups respond differently to an increasing speed than to a decreasing speed, it seemed reasonable to look at that difference as a part of a performance test. The common test method for distance constant uses a simulated step increase in speed. The cup wheel is restrained in a steady flow in a wind tunnel, abruptly released, and the rate of rotation measured as the indicated speed goes from zero to the tunnel speed.

How can a simple simulation be designed for a decreasing step function? Assume a 10 m s^{-1} test speed. The suggestion in my paper represents a sort of mirror image of the increasing step function. The sensor is placed in the environment of final equilibrium (10 m s^{-1} for increasing step and 0 m s^{-1} for decreasing step). At the start of the test it is required to simulate mechanically a speed different from the equilibrium (0 m s^{-1} for increasing step and 10 m s^{-1} for decreasing step). After abruptly releasing the sensor from the mechanical aberration, a time constant is measured. The problem comes, as Acheson points out, if the time constant is multiplied by the final equilibrium speed to get the distance constant for a decreasing step change, L_d. One solution, as described in the suggestion, is to use the speed toward which and from which the sensor is moving, preserving the mirror image concept.

The second reason for the difficulty Acheson reports contains two points: first, the "aerodynamic concept" and second, the frictional effect of the bearings. It is precisely because the aerodynamic (lift/drag) response to an increasing speed is different from that of a decreasing speed that the second test is suggested. Heavy cups, like the one reported on in the subject paper, have an L_i/L_d ratio of about 0.25. With no inertia and no bearing friction the ratio should be 1. I would expect that the lighter the cup the closer to 1 the ratio would be, if the tests are limited to speeds or apparent speeds well above bearing friction influence.

All dynamic response tests (except starting threshold) should be conducted at speeds away from the influence of bearing friction. The L_d test at "10 m s^{-1}" would measure the time between 74.2% (7.4 m s^{-1}) and 30% (3.0 m s^{-1}) of the step change. If 3 m s^{-1} is not two or three times the starting threshold, the simulated speed should be higher. The use of nonzero speed (0.3 m s^{-1} suggested in the paper) was never intended as a speed at which the sensor would operate.

It is more important for standard tests to be simple and objectively conducted than to be analogous to free atmospheric motions. It is also important that tests be designed to require the sensor to respond to all the forces which influence its performance in the atmosphere. Standard tests make the comparison of different sensors meaningful. The interpretation of performance characteristics for specific applications of the sensor is also an important and difficult task. It was with this interpretive task in mind as it applies to the assessment of measurement accuracy in turbulent flow ("overspeeding" error in calculating the mean wind speed) that the test for L_d was suggested.

REFERENCE

Acheson, D. T., 1988: Comments on "Anemometer Performance Determined by ASTM Methods." *J. Atmos. Oceanic Technol.*, **5**, 381.

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