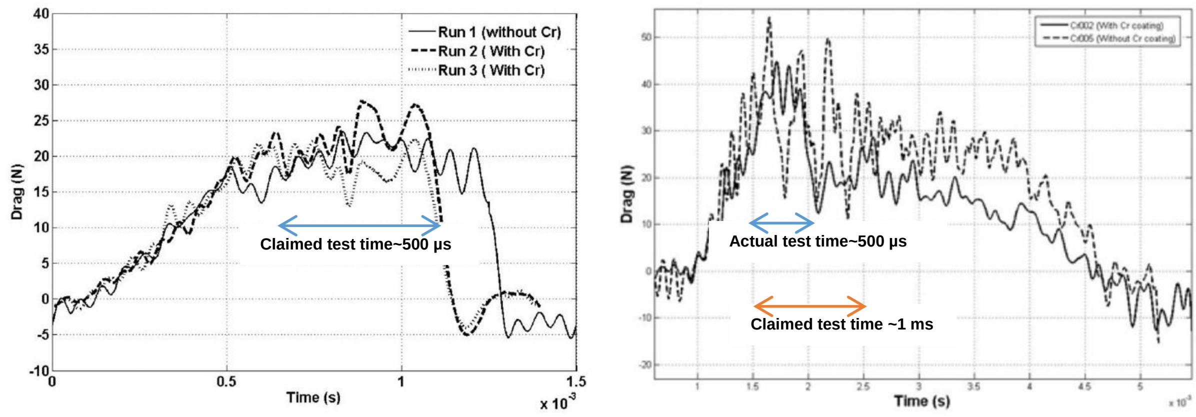
Comments on “Aerodynamic drag reduction by heat addition into the shock layer for a large angle blunt cone in hypersonic flow” [Physics of Fluids 20, 081703 (2008)]

Anbuselvan K.K.N.

Patent Analyst, Airbus India Private Limited.

The article[1] showed a 47% drag reduction and 18% increase in shock stand-off distance with chromium coated surface whereas A.M. Tahsini[2] performed numerical simulations of Kulkarni et al.[1] work and found a large discrepancy (>50%) with the experimental results. The reason for the discrepancy is found in this comments to be improper data analysis of the experimental drag signals.

Kulkarni et al.[1] carried out experiments at 2 MJ/kg and 3.4 MJ/kg flow conditions for the Cr coated test model and uncoated test model. The drag signals at 2 MJ/kg and 3.4 MJ/kg for both the test cases are shown in Figure 1a. It is shown that the drag values are unchanged between the two test cases at 2 MJ/kg, and drag reduction with Cr coated test model at 3.4 MJ/kg.



(a) 2.3 MJ/ kg **(b) 3.4 MJ/kg**

Figure 1: Measured drag signals for the blunt cone model with and without chromium plating in Mach 8 hypersonic flow [*Taken from Kulkarni et al* [1] *and edited it*]

On inspecting the drag signals, Figure 1a shows the drag signal's rise time is 500 μs and steady time is 500 μs at 2.3 MJ/kg enthalpy condition whereas Figure 8b shows the drag signal's rise time is 500 μs and steady time is 1000 μs at 3.4 MJ/kg enthalpy condition. The increase in total test time from 1 ms at 2.3 MJ/kg to 1.5 ms at 3.4 MJ/kg is not explained in their article. Logically, the test-time reduces with higher enthalpy flow because of the fixed flow volume in the shock tube. If the drag signal's rise time and steady time is considered as 500 μs for 3.4 MJ/kg test flow condition, then the drag signal seems to be unchanged or changes by a minuscule amount between Cr coated test model and the uncoated test model (See Figure 1b).

References:

1. Kulkarni, Vinayak & Hegde, GM & Gopalan, Jagadeesh & Arunan, Elangannan & Reddy, K P. (2008). Aerodynamic drag reduction by heat addition into the shock layer for a large angle blunt cone in hypersonic flow. Physics of Fluids. 20, 081703 (2008).
2. M. Tahsini, A. (2013). Heat release effects on drag reduction in high speed flows. International Journal of Heat and Mass Transfer. 57. 657-661.