Journal of Visualization, Vol. 9, No. 1 (2006) 8

Control of Vortex Shedding from a Hemisphere by Local Suction

Kang, Y. -D.* and Choi, K. -S.*
* School of Mechanical, Materials and Manufacturing Engineering, University of Nottingham, University Park, Nottingham, NG7 2RD, U.K.
E-mail: kwing-so.choi@nottingham.ac.uk
Received 20 October 2005

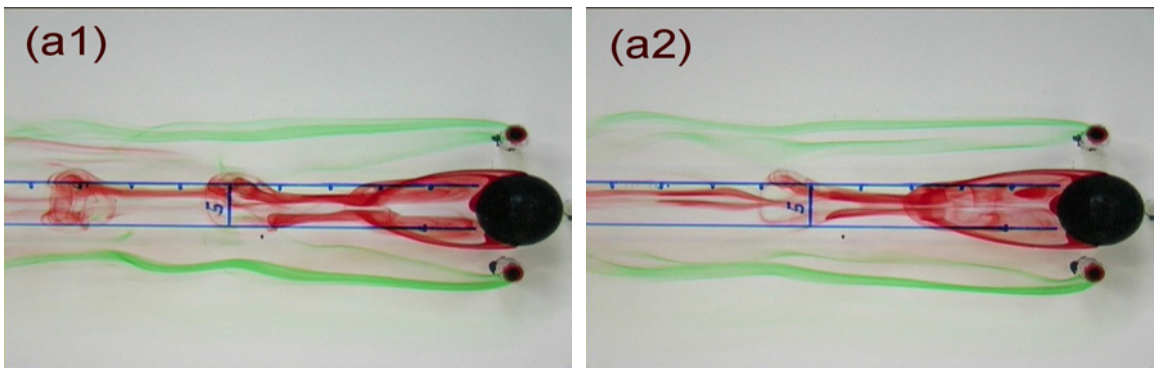

Fig. 1. Wake region of a hemisphere in the laminar boundary layer without suction (left) and with suction (right) at a suction rate of SR = 3.1.

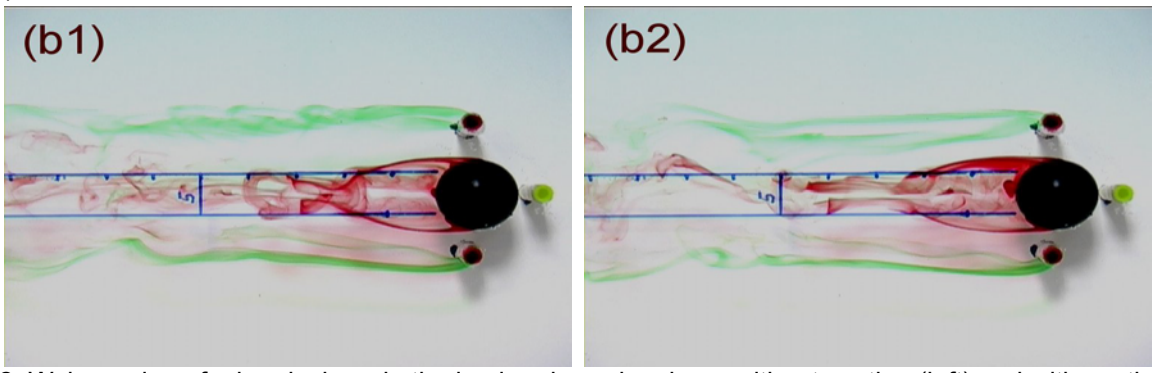

Fig. 2. Wake region of a hemisphere in the laminar boundary layer without suction (left) and with suction (right) at a suction rate of SR = 1.47.

A water channel experiment was carried out to investigate into a possibility of controlling vortex shedding from a hemisphere in the laminar boundary layer. This work was conducted by modifying the necklace vortices around a hemisphere by local wall suction, thereby reducing their interaction with the shedding hairpin vortices. The boundary layer over the test plate was laminar, where the Reynolds numbers based on the distance from the leading edge were 2.7×10^4 and 4.0×10^4 with the freestream velocity of 0.074 m/s and 0.107 m/s, respectively. The corresponding Reynolds numbers based on the diameter of hemisphere were 1.26×10^3 and 1.82×10^3, respectively. We visualised the wake region of a 17 mm diameter hemisphere by colour dye injection, where the baseline flow (left) is compared with a controlled flow by local suction through 2.5 mm diameter hole, 3 mm upstream of the hemisphere (right). It seems that the induction of high speed fluid into the wake region is reduced as the strength of necklace vortices is weakened by suction. As a result, the shedding frequency of hairpin vortices has been reduced by 12.4 % for the suction ratio (defined as a ratio of the suction pressure to the freestream dynamic pressure) SR = 3.1 and by 7 % for SR = 1.47. It was also observed that the local wall suction has extended the wake region of a hemisphere further into downstream. This suggests that the local wall suction has moved the flow separation point into upstream over the hemisphere, thereby increasing the area of wake region.

*The work was funded by Advanced Ship Engineering Research Center, Korea. The first author acknowledges the financial support received from ORS (UK) studentship and KOSEF (Korea) scholarship.