Aerodynamic drag study of time-trial cycling helmets using CFD analysis

ABSTRACT

In cycling events, aerodynamic drag contributes most of the resistance experienced by a competitive cyclist. Accordingly, the majority of time-trial cycling helmets were designed to obtain low aerodynamic drag. The question arises what is the best position of cycling helmet and its tail flap that resulted in the lowest drag coefficient. This paper presents an aerodynamic drag analysis of helmet with different tail flap positions at a constant speed of 60 km per hour. The objective of this paper was to investigate the drag coefficient between the different designs of helmet and tail flips using CFD and thoroughly study the airflow near the surface of the cyclist helmet. The results are compared with the exceptional time trial cycling helmet in the market. Design of a 2Dmodel of cycling helmets is developed using GAMBIT software. Six helmet designs comprising varying tail flap positions were tested under ideal cycling position. The designs are the existing time trial cycling helmet available in the market (Helmet 1), the modified helmets with tail flap at 0, 3, 6 and 9 degrees to horizontal (Helmet 2 to 5) and the modified 10 degrees rotated helmet (Helmet 6). The computational fluid dynamics simulations are performed using ANSYS Fluent and the results in terms of the reduced drag coefficient and flow characteristics for optimal aerodynamic performance are analyzed. It is shown that the tail flap position of 6 and 9 degree to horizontal produce considerably low drag coefficient with 0.06 and 0.05, respectively, while the modified 10 degree rotated helmet recorded the highest drag coefficient due to large frontal area and flow separation. Evidently, closer tail flap to the back of the cyclist and smaller pressure difference resulted in the low drag coefficient.

Keyword: Aerodynamic drag; Time-trial; Cycling helmet; CFD analysis; Fluid flow