

CFD Analysis of Golf Ball with Various Turbulence Models.

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Abstract:In this research work we investigate the performance of golf ball with 256 circular arc dimples on golf ball. The turbulence characteristics and flow pattern over golf with various velocities investigated by computational fluid dynamics in suitable turbulence model, in addition that the distance covered by a ball and rotational motion characteristics also investigated with same turbulence model.

Keywords: Circular arc dimples, Golf ball, CFD

Introduction

In olden days we design our model without considering the aerodynamics characteristic but later they understood how the aerodynamic force affect the performance that model because the aerodynamics is a dynamic force it creates the aero elastic, buffeting, fluttering, clapping on models like bridges, building, automobiles, wind turbine and sports goods. So while design these model we should consider about aerodynamics force on model, how much amount of lift and drag force is produced on that model, what is magnitude of circulation based on wind force and dimensions, then only we can define the structural capability, performance of that particular model. The application of aerodynamics not only in aircraft and also is used to design tall buildings, bridges, wind turbine and sports goods.

In this research work we took one sports goods model for our analyzing, the golf ball is taken in account here the golf ball surface shape is modified by while implementing 256 circular arc dimples. The golf ball designed in Solidworks and analyzed in CFD software. The performance of golf ball is measured by while taking the results for wall shear stress, eddy viscosity, pressure and turbulence kinetic energy from these result we can easily understand what is the distance covered by ball and spin rate.

MODELING

Modeling of golf ball done in solidworks software with the dimensions of 50mm diameter with the 256 surface dimples on the golf ball surface CFD domain of golf ball is modeled as 2times of diameter in front of the ball top and bottom also as well as same, in back side 10 times of the diameter is taken for CFD domain modeling

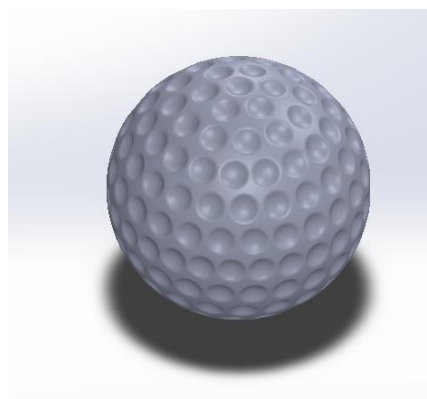


Fig 1: 3D Model of Golf Ball

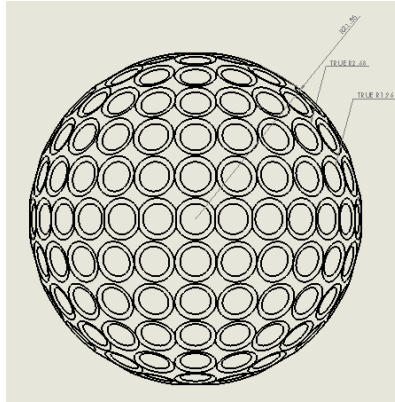


Fig 2: 2D Model of Golf Ball

CFD Simulations

The CFD simulations of the golf ball is done in ANSYS Fluent Software and the mesh model of the golf ball CFD Domain model is meshed by using Tetrahedral elements with 107546 nodes and 586481 elements. Finite Volume method (FVM) based Solver ANSYS Fluent Software is used for this CFD Simulation with the various turbulence models of k-epsilon, k-omega and SST K-omega model is used for this simulations.

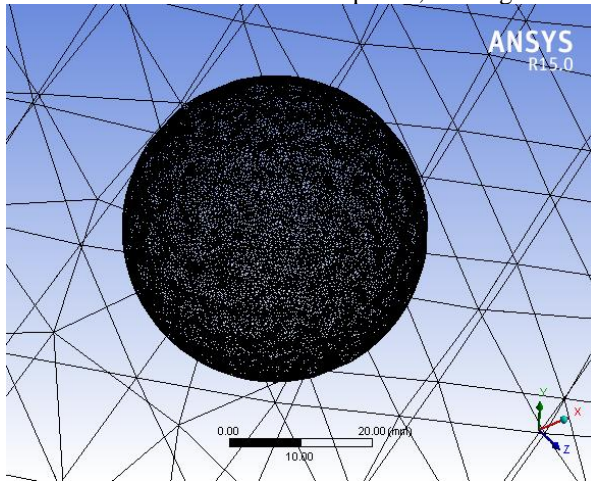


Fig 3: Mesh Model of Golf Ball

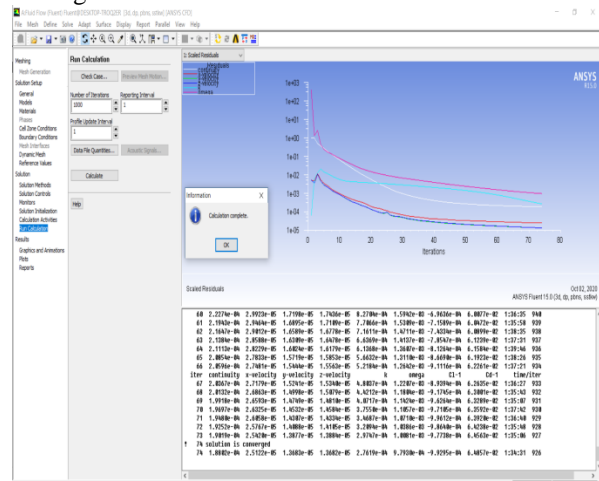
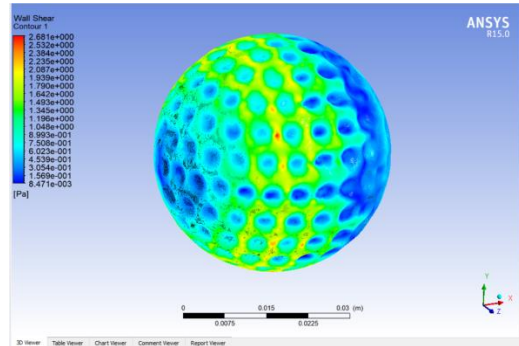


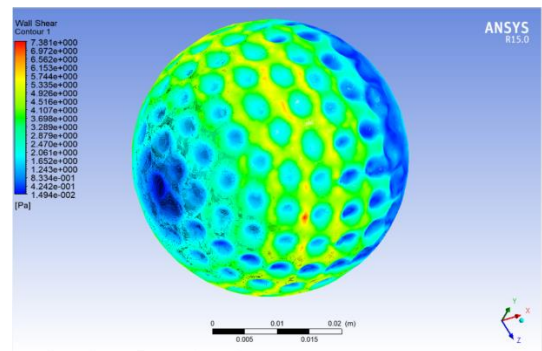
Fig 4: CFD Convergence of Golf Ball analysis

Results and discussion:

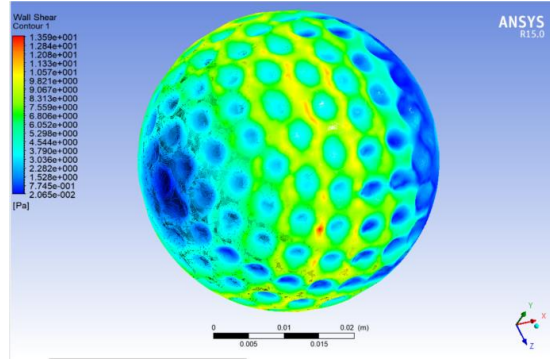
Wall shear stress:



10 m/s

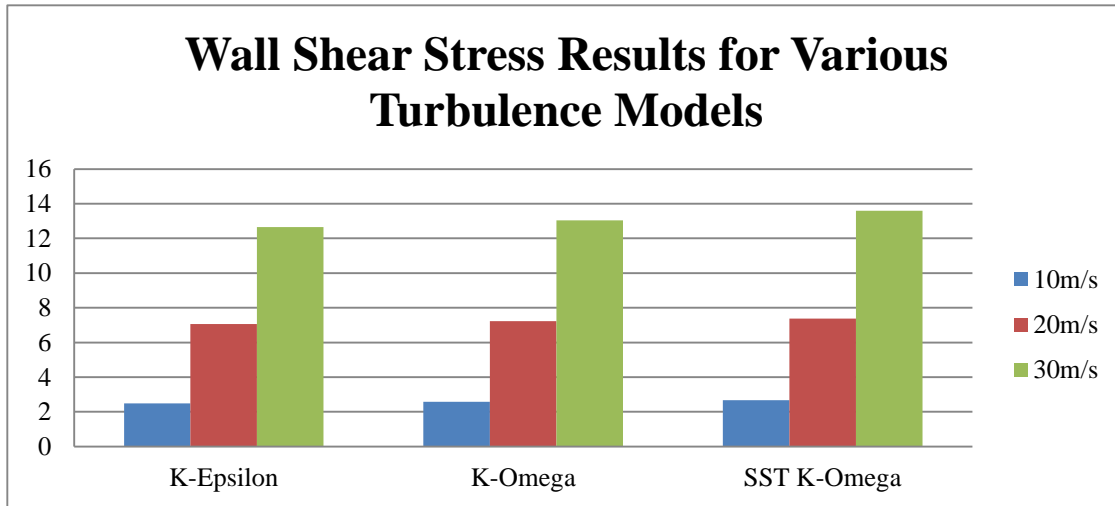


20 m/s

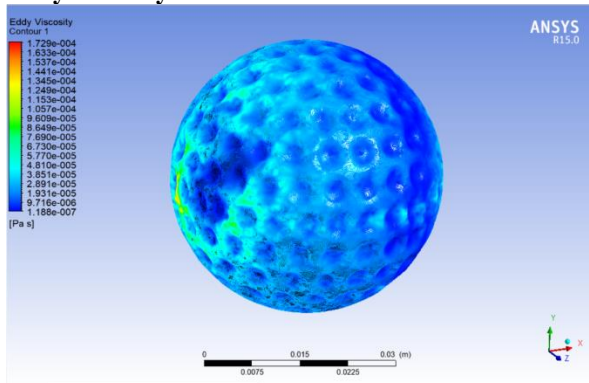


30 m/s

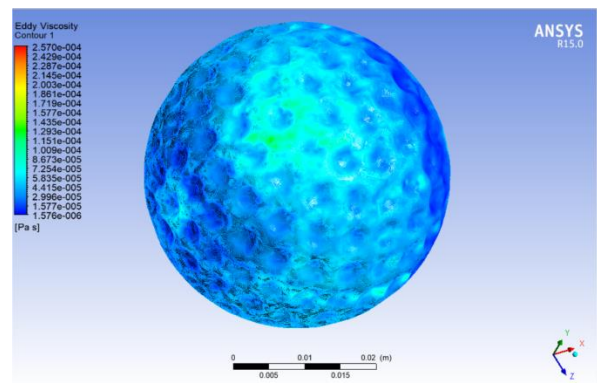
Wall Shear Stress	K-Epsilon	K-Omega	SST K-Omega
10m/s	2.482	2.586	2.681
20m/s	7.06	7.226	7.381
30m/s	12.66	13.04	13.59



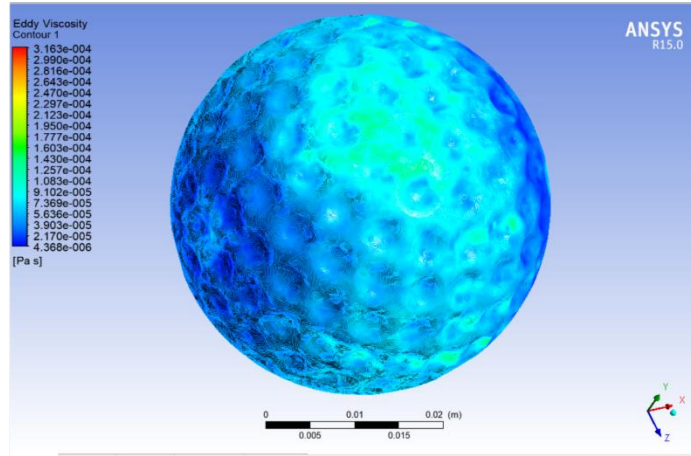
Eddy viscosity



10 m/s



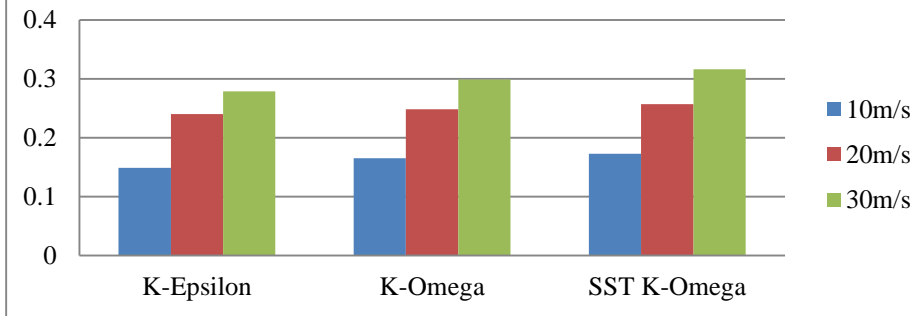
20 m/s



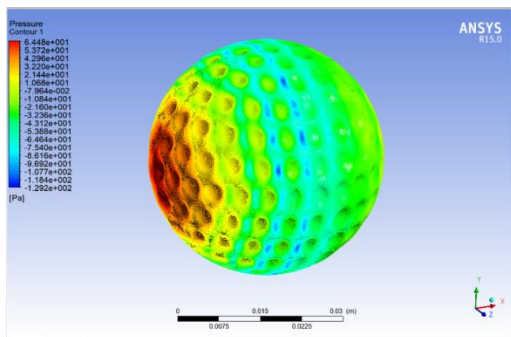
30 m/s

Eddy Viscosity	K-Epsilon	K-Omega	SST K-Omega
10m/s	0.1488	0.1655	0.1729
20m/s	0.2402	0.2486	0.257
30m/s	0.2786	0.299	0.3163

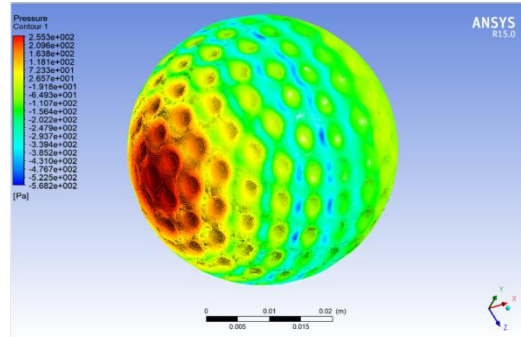
Eddy Viscosity Results for Various Turbulence Models



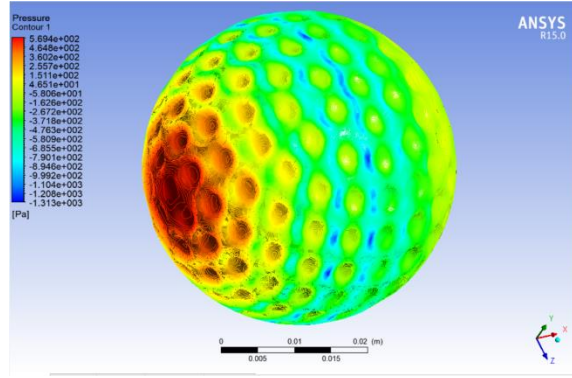
Pressure:



10 m/s

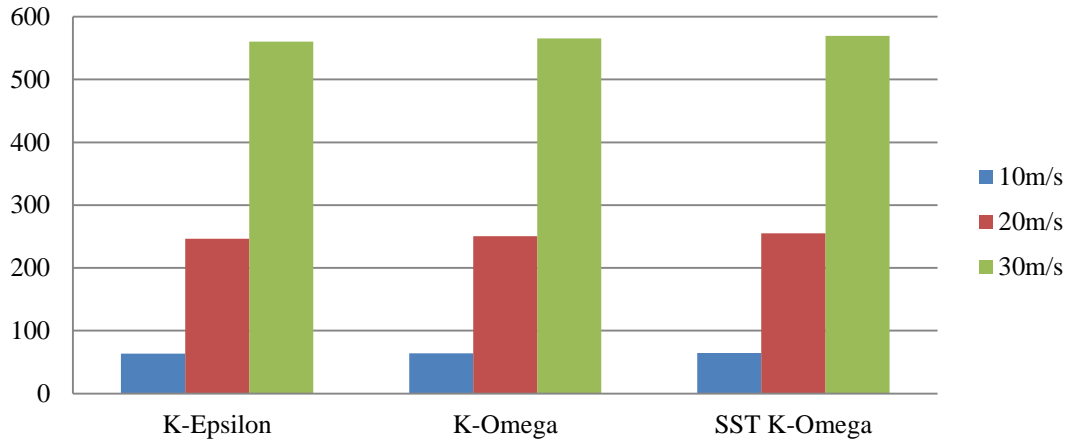


20 m/s



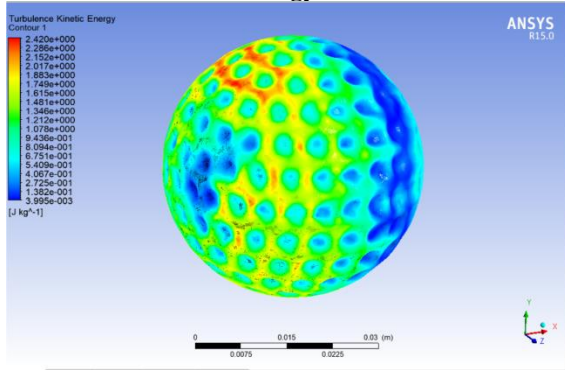
30 m/s

Pressure Results for Various Turbulence Models

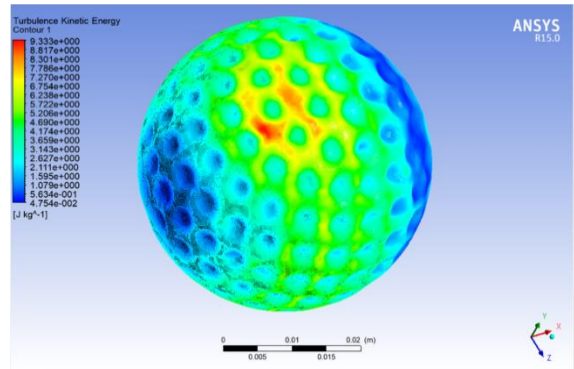


Pressure	K-Epsilon	K-Omega	SST K-Omega
10m/s	63.6922	64.225	64.48
20m/s	246.36	250.69	255.3
30m/s	560.214	565.208	569.4

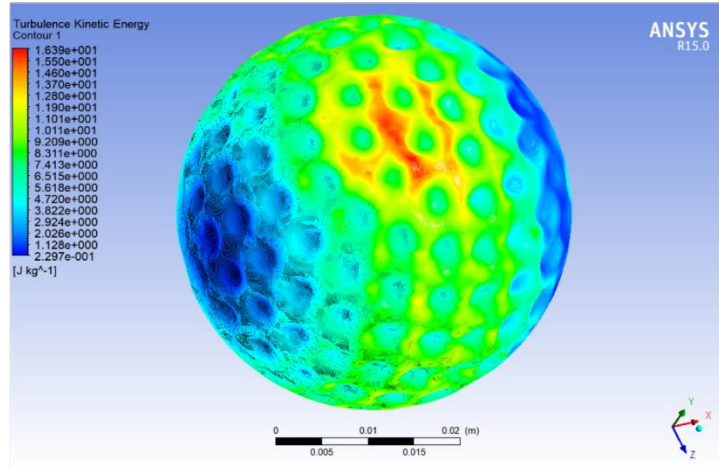
Turbulence Kinetic Energy:



10 m/s

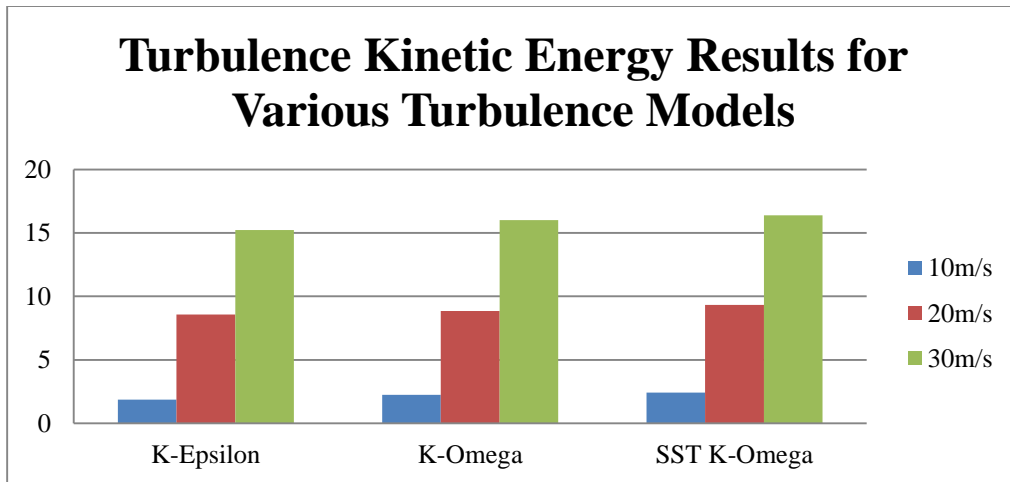


20 m/s

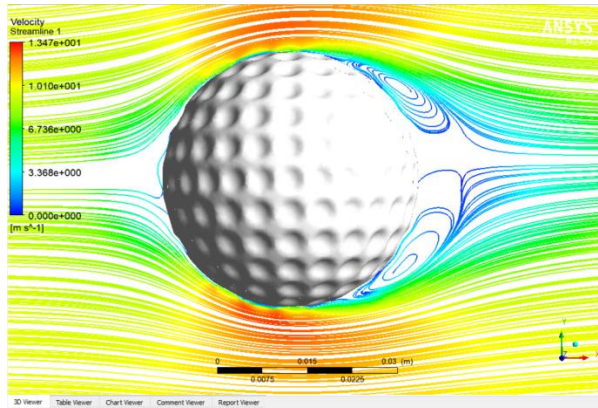


30 m/s

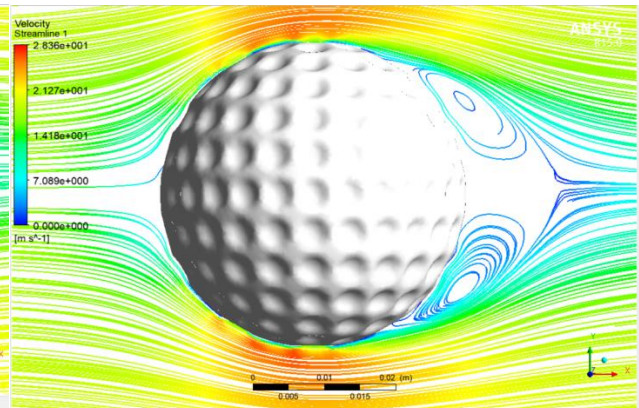
Turbulence Kinetic Energy	K-Epsilon	K-Omega	SST K-Omega
10m/s	1.866	2.226	2.42
20m/s	8.564	8.856	9.333
30m/s	15.24	16.02	16.39



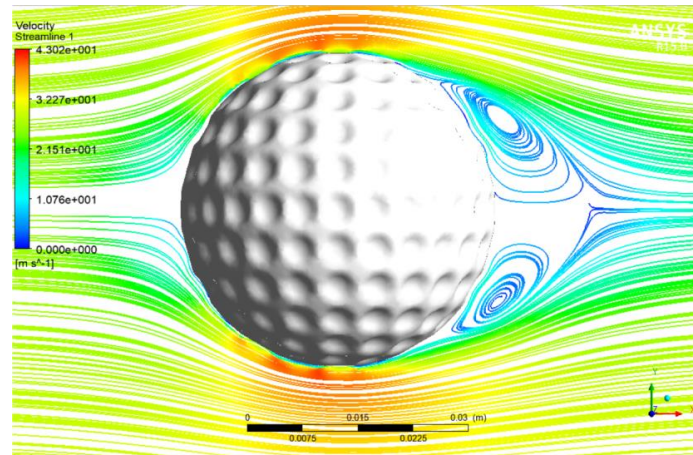
Streamline flow:



10 m/s



20m/s



The streamline flow results of golf ball for various flow velocity conditions of 10m/s, 20m/s and 30m/s, in 10m/s velocity conditions wake regions create the circular motions with short distance of vortices, 20m/s flow velocity large distance of vortices and top of the flow low strength and bottom of the ball have more strength of vortices, 30m/s of flow will create the perfect elliptical shape of vortices

Conclusion:

The Golf ball flow analysis was done in ANSYS Fluent software with the various velocities of 10m/s, 20m/s and 30m/s of velocities wall shear stress, Eddy viscosity, Turbulence kinetic energy, Pressure results and streamlined flow results can be analyzed with the various turbulence models results comparison will show SST K-omega turbulence models give the better results in the Golf Ball analysis but in the high velocity conditions the wake regions creates the parabolic shapes of vortices

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