Hi speed airfoils for flying models

by Slobodan Midic

After news published in TNG-Tehnology consulting-Big Techday 10, The 835 km/h Sailplane and Dynamic Soaring, Spencer Lisenby, Prototyp-entwickler bei DSKinetic, I was more interested about Dynamic Soaring and specific airfoils at that gliders for hi speed.

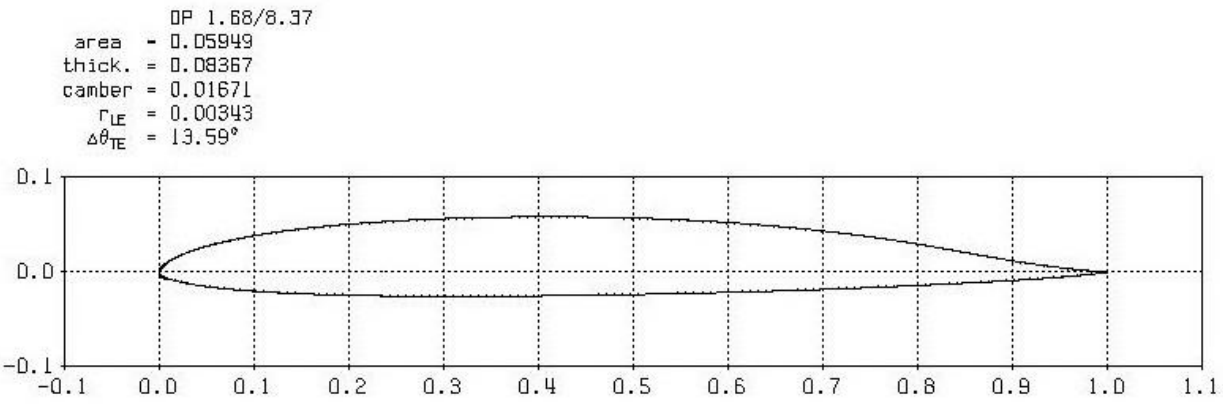
At the first I wish congratulate to entwickler and record holder for so unbelively hi speed of 835 km/h (232m/s), without any drive at so "normal" RC glider. Bravo, this is fantasstic! But..., the model is not normal, only luck like so from outside.

I was not informe about this kind soaring and that model up to now. Then I beginn to lern what models need so big speed. And I has founde that is the kind in RC pylon racing where the speed of small models, of about 15dm2 wing, reaches more than 300km/h, than at proppelers and also at some type of RC motor gliders for hi speed, by rotors at helicopters, and so on..

At one RC pylon racing model with squer wing, cord of about 0.15m, wing span is 1m, and at the speed of about 360km/h=100m/s, Reynolds number of wing is Re=1,050,000, and the Mach number is Ma=0.29 (Mach number is ratio between speed of model and speed of sound). At so big Mach number must calculate with compressibility of air what diminishes good flying caracteristics but the program Xfoil of Mark Drela can analise airfoils at that Re and Ma numbers without any problem. It is the question what kinde of airfoil is the best for that speed, because usable normal airfoils have too big drag, as a consecuence of relative short laminar path at upper surface, so the laminare transition point must be puled more beck too trailing edge for bigger speed.

Analyse of airfoil for big speed give that the point of maximal thickness of airfoil must be at the distance of more than 35% of cord. Also the leading edge radius must be smaller (about 0.35*c). The thickness of airfoils are about 7%-9%c, and cambers are 0.5%c-2%c. Point of maximal camber need to be at about 0.45%c and in some cases airfoils are symmetrical without any camber.

Maybe the best airfoils for flying models with speed over 500km/h is the series DP designed by Dirk Pflug for Dinamic Soaring (DS). Here is one of them: DP 1.68/8.37_DS (c)”Dirk Pflug”.



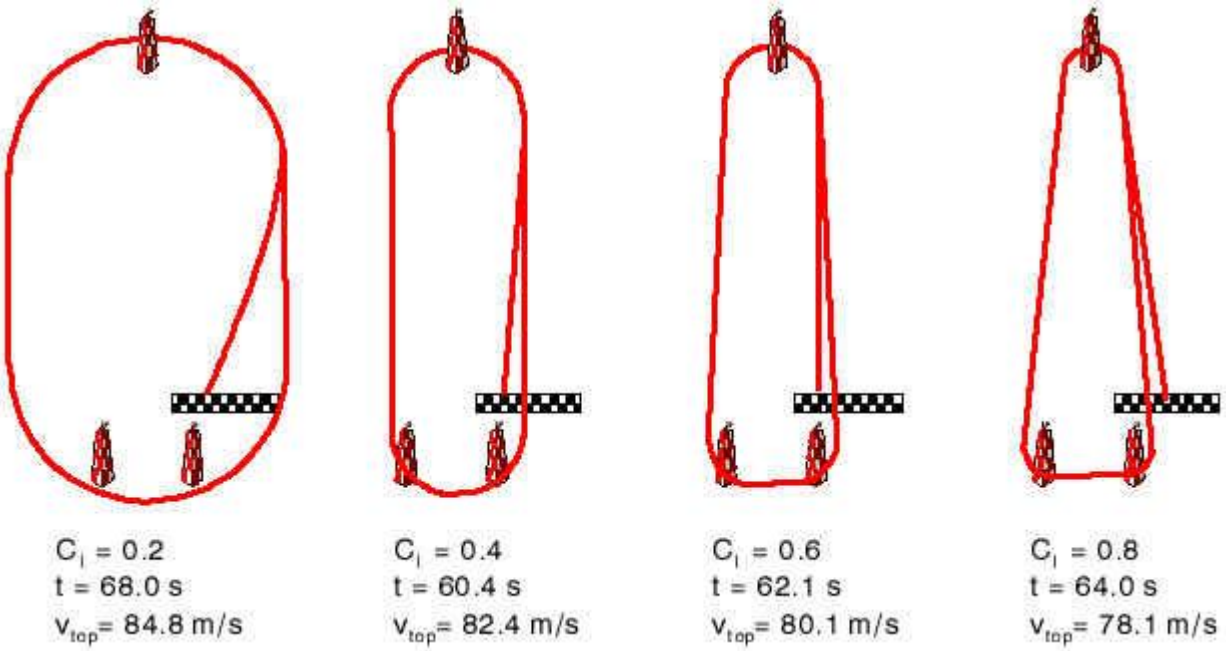
That airfoil has maximal thickness of 8.37%c at the distance of x=38.7%c, and the maximal camber of 1.67%c at the distance of x=46.3%c.

In the most interesting range of atack angles from zero up to 2 degre point of transition from laminar to turbulent flow at upper side of airfoil, at the speed of 140m/s (504km/h), drop from 80%c to 60%c, what means very small drag. Minimal coeficient of drag is Cd=0.00299 at Alfa =0.5 deg. Also because of small reflexed camber near the trailing edge, airfoil have very low coefitient of moment of Cm=-0.025.

With increasing the atack angle of airfoil from zero degree increase the maximal local speed of air and increase the minimal negativ coeficient of presure Cp of airfoil on the upper side and move closer to leading edge (LE). At Alfa=0deg is the minimal Cp=-0.4 at about x=15%c. At Alfa=2deg is Cp=-0.7 at about x=4%c. At Alfa=4deg is Cp=-2.0 at about x=0%c (LE). At Alfa=5deg Cp suddenly increase to -3.5, what means local speed at LE reaches sonic speed and can go to local sonic shock of air. At the airfoil DP 1.68/8.37 that critical atack angle is Alfa=4.76deg.

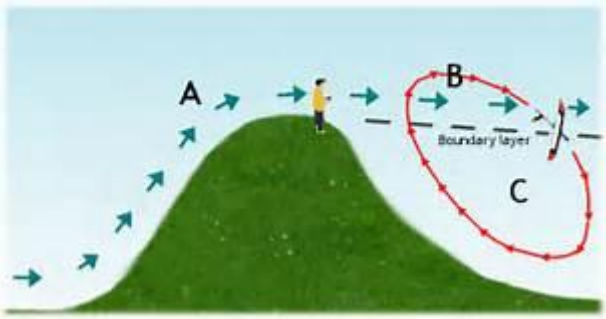
“Using the DP-DS airfoils are made for extreme top speed DS sessions (Re=1,000,000-2,000,000). They start to run at a speed of 40m/s (144km/h) or more. They are thick so that is easier to built a rigid wing and damfast. If you will use them for a normal F3B or F3F soarer you will be disappointed.” - say airfoil designer.

By RC pylon racing more competitors start their RC motor planes of about 1m span and weight of 1kg and make 10 tourns around pilons. The winner is the pilot with model who cam first to the goal.
Two closer pylons are at the distance of 40m, third pylon is at the distance of 180m from two closer.

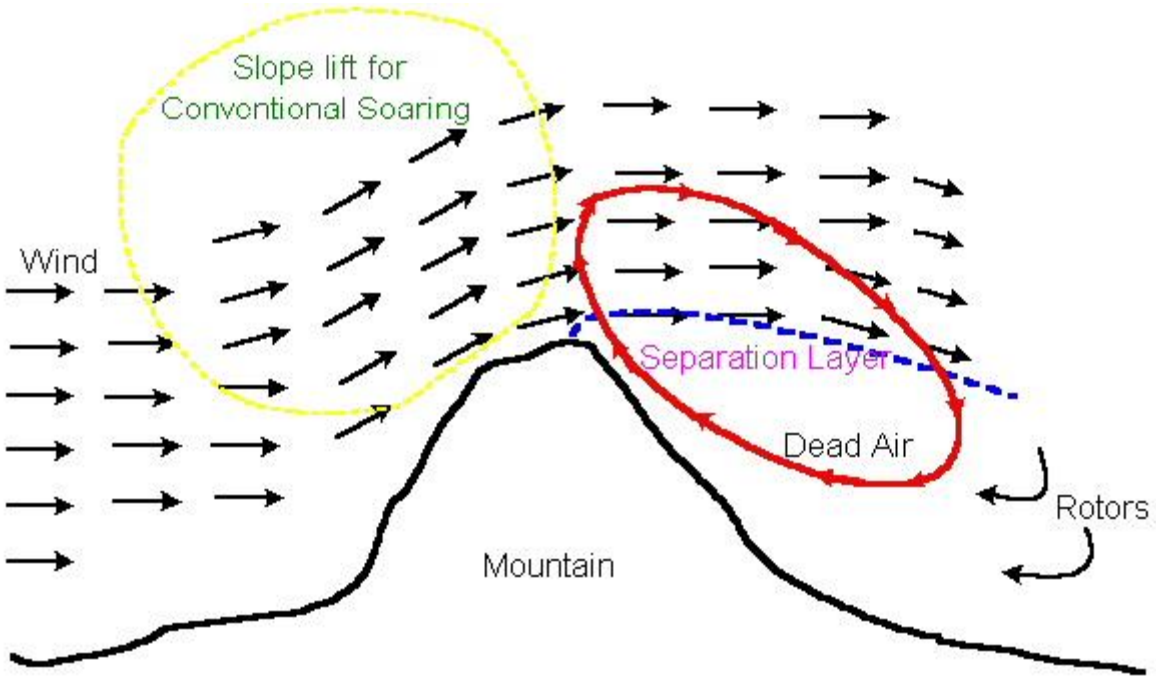


As can see speeds go more than 300km/h but for winning nedd to be smart.
For RC pylon racing there are also some other airfoils but DP airfoils can be also good.

Dynamic soaring is a flying technique used to gain energy by repeatedly crossing the boundary between air masses of significantly different velocity. Such zones of high wind gradient are generally found close to obstacles and close to the surface, so the technic is mainly of use to birds and operators of radio-controlled gliders. Glider pilot can been able to soar dynamically in meteorological wind shears at higher altitudes. So reported highest speed of radio-controled glider of 835km/h.



Difference between conventional slope soarind (left) and dynamic soaring (right):



On the left side of picture long glider soaring on slope use lifting component of wind but on the right side of picture glider fly in cyrcles get energy from wind only on the top of cyrcle (above separation layer) but longer path is in the dead air behand mountain.