XFLR5 tutorial

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This tutorial was been written in 2024 for the homework of the project for the course Aerodynamics of External Flows (LMECA2323) given at the EPL (UCLouvain).

This tutorial explains how to create a polar for an airfoil using XFLR5.

Prerequisites

Having XFLR5 installed on your computer.

1 Creating a polar

Open XFLR.

1.1 Start a direct analysis process

Module > Xfoil Direct analysis.

1.2 Selecting an airfoil

NACA profile

Design > Naca Foils > *Enter the desired NACA-id and specify the number of panels.*

From a file

At the top left of the "Direct analysis" window, you have a few buttons. The second one allows to open a file. Select the desired file.

1.3 Set the number of panels

In the "OpPoint view" (fourth button at the top left of the window), you can see the airfoil that is displayed and that its characteristics are written at the bottom left, including the number of panels.

If you are not happy with the number of panels:
Design > Refine Globally > *Set the number of panels.*

Note: Sometimes clicking the "ok" button is not sufficient for XFLR to update the settings, so first hit "Enter" on your keyboard, then click the "ok" button. Double-check that your changes in the settings are well taken into account.

1.4 Start an analysis

Go to:
Analysis > Define an Analysis.
and set up the different settings of the analysis. You will mainly use "type 1" analysis. Set the Reynolds number. We also ask to set Ncrit to 0.5 (in short this parameter influences the location where the boundary layer transitions from laminar to turbulent (still no separation/stall), this reflects the amount of perturbation you would have in the inflow).

Now you are able to modify the analysis settings in the right sub-window. You can either investigate single or sequences of angles of attack. Verify that "Init BL" is ticked, and "Store Opp" if you want to save those angles.

Finally, click "Analyse" to evaluate the defined operating points.

Note: The default maximum number of iterations made by Xfoil to solve the viscous problem is relatively low. You can increase it (e.g. to 1000) in Analysis > Xfoil Advanced Settings > Iteration Limit. Also check that "Re-initialize BLs after unconverged iteration" is ticked.
XFLR works using iterations and uses the last results as a guess for the next operating point calculation. Without a good guess, it will best converge at an angle of attack close to the zero lift angle. Then if you want to investigate a range of angle of attack, if $0°$ is the zero lift angle and you want to investigate angles of attack from $-10°$ to $10°$, it could be that it performs best if you ask from $0°$ to $10°$ and from $0°$ to $-10°$, i.e start from an easy situation and avoid big jumps in operating conditions.

1.5 Vizualise your results

On the left, there is a sub-window with a drop-down menu that contains the investigated analysis and operating points (if stored).
On the "OpPoint view" you can visualize the Cp distributions and the polar on the "Polar view" (fifth button at the top left of the window).

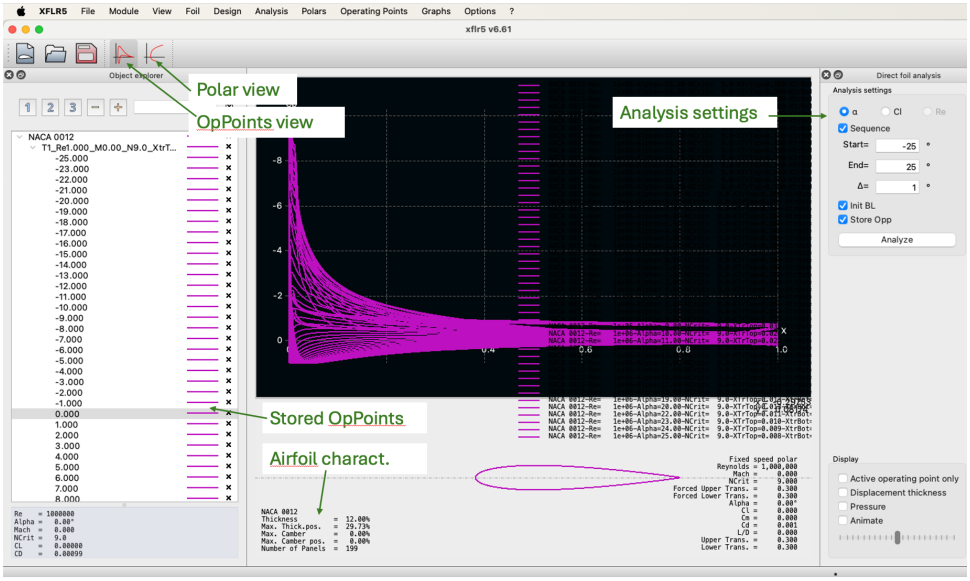

Figure 1: XFLR "Direct Analysis" window.

1.6 Save a polar and project

In the left dropdown menu, right-click on the analysis you want to save (under your airfoil name) > export.

It will save the polar containing all the stored points to a .txt file. It is then easily readable in Python.

You can also save all the setup via the "Save" button or File > Save (the save format is .xfl).