Evaluation of the Eppler 1210 Airfoil

January 18, 2020

1 Introduction

1. show airfoil
2. table of freestream conditions and Re
3. xfoil estimates of:
   - max L/D ratio, and AoA at which this occurs
   - max C_l, and AoA at which this occurs
   - Note: take both of the above directly from airfoiltools.com, at the closest reynolds number available

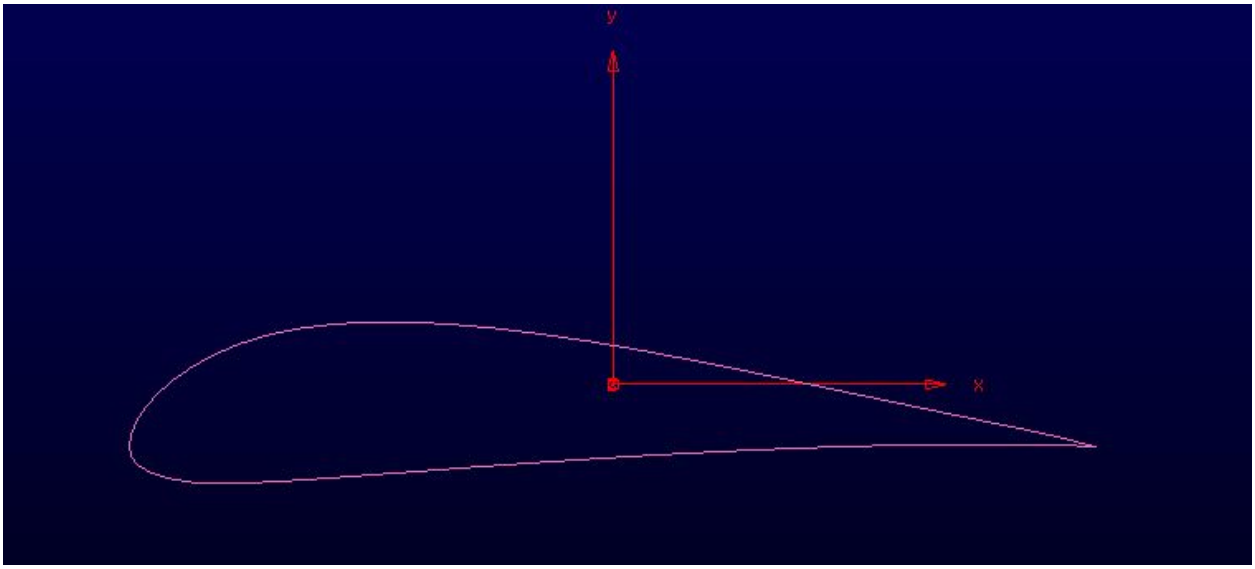


Figure 1: Eppler 1210 Airfoil shown in Pointwise

Quantity	Value
Pressure	103,000 Pa
Temperature	298 K
Velocity	17.88 ms^{-1}
Viscosity	1.789e-05 $kgm^{-1}s^{-1}$
Re #	1,224,315

Table 1: Operating conditions for all cases

	Value	AoA
Max L/D	117.1309	8
Max C_L	1.8542	16

Table 2: XFoil Predictions, Re = 1e9, ncrit = 9 (clean wind tunnel)

2 Methodology

1. 4 shots of grid: 1. LE 2. TE 3. near-field for entire shape 4. the entire grid domain. Note: should show T-rex feature that was used

2. table 1: cell count and normal-to-wall spacing used, list BC, list reference values, list submodels chosen (i.e. viscous model), provide numerical scheme and spacial accuracy

2.1 Screenshots of grid

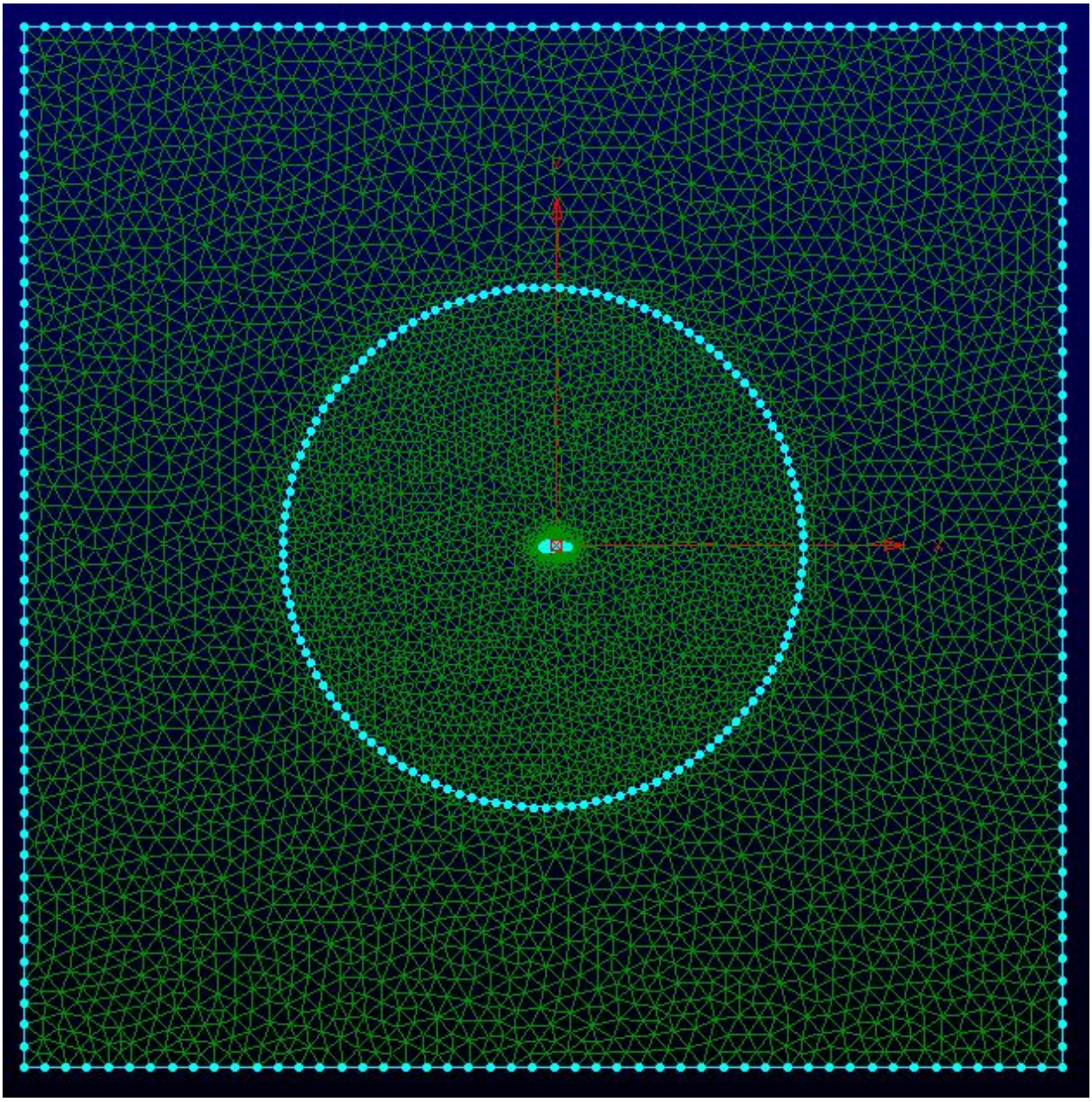


Figure 2: Farfield

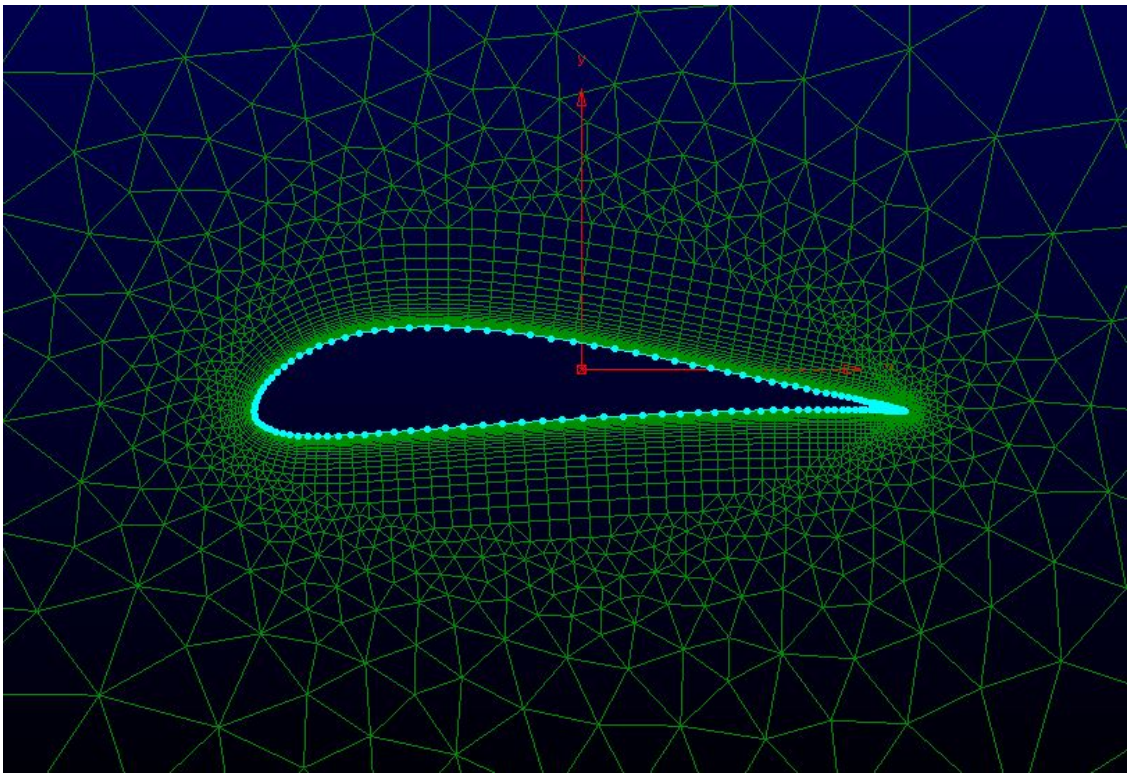


Figure 3: Nearfield

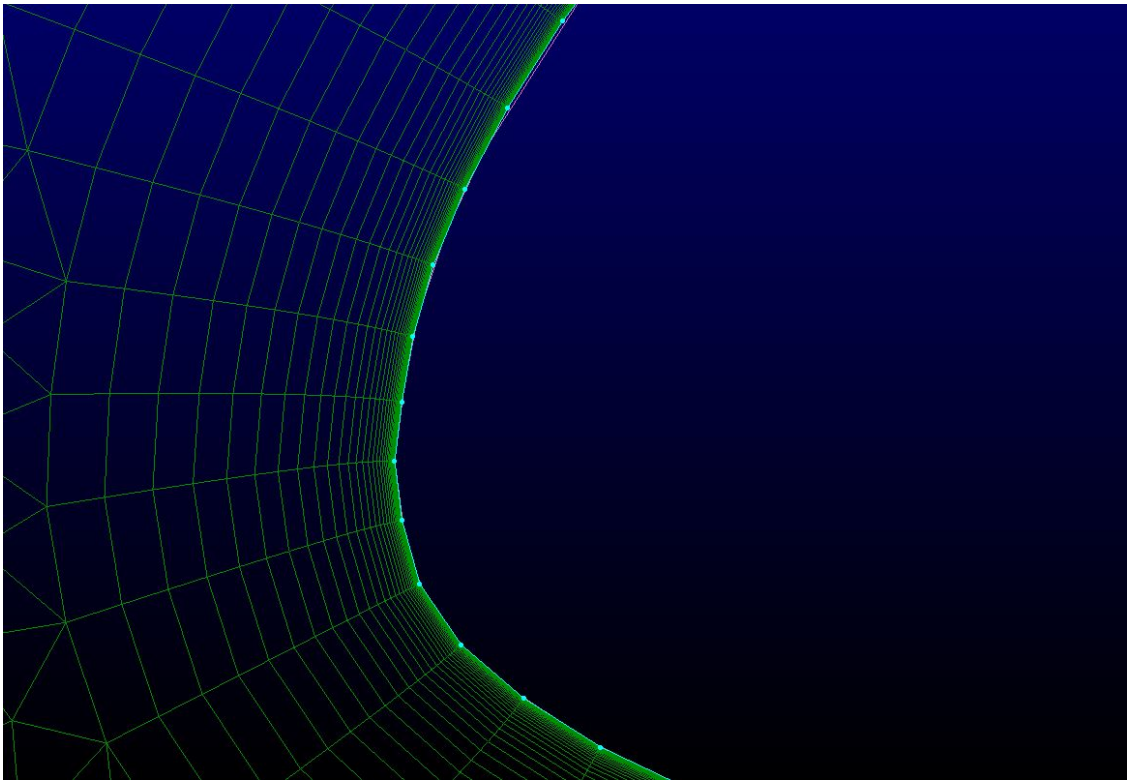


Figure 4: Leading edge

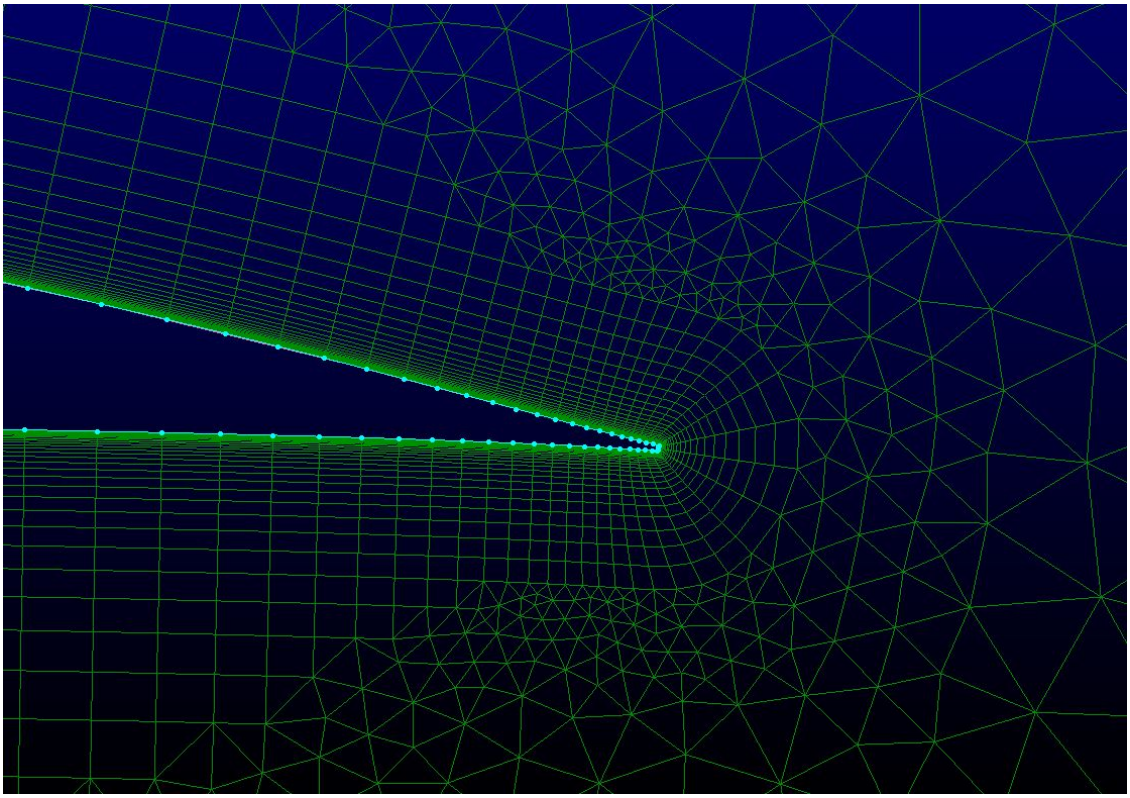


Figure 5: Trailing edge

	Value
Cell count	inner mesh: outer mesh
Normal-to-wall dist	1e-5 (UNITS?)
Boundary condition	airfoil surface: wall, Δs=1e-5 (might have to specify at inlet and such, check)
Reference values	A bunch of different ones here, 1.789e-05 $\mathrm{kgm^{-1}s^{-1}}$
Submodels	viscous: transitional SST
Numerical Schemes	**gradient**: least-squares cell based **pressure**: second order **momentum**: second order upwind **turbulent kinetic energy**: first order upwind **specific dissipation rate**: first order upwind **specific dissipation rate**: first order upwind **intermittency**: first order upwind **momentum thickness Re**: first order upwind

Table 3: General grid information

3 Results

1. plot lift and drag coeff histories for proof of convergence history for ALL Runs (appendix)
2. Table of C_l, C_d, L/D, C_m

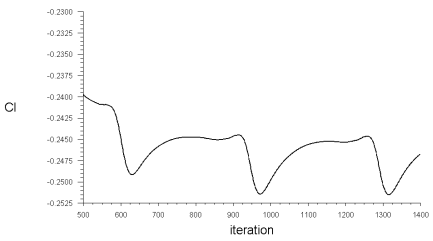
3. plots of the items in the table and compared against Xfoil data at the closest Re # (take directly from airfoiltools.com)
4. streamlines and pressure contours to depict flow near airfoil
    - 1 plot for each case
    - use the same contour levels
5. y+ curves (for 0° AoA case)
6. plot showing turbulent boundary layer development (0° AoA case)

4 Discussion

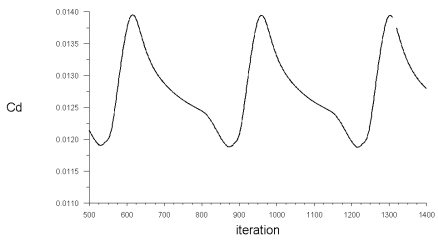
Is the agreement between your CFD model and XFOIL within this same tolerance level for lift and drag? (10% error bar)

Appendix A

AoA = -7



(a) C_l for AoA = -7



(b) C_d for AoA = -7