

The Gö 622, Gö 623, Gö 624 and Gö 625 airfoils with thickness/chord ratios of respectively 8 %, 12 %, 16 % and 20 % for use in windmill rotor blades

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1 Introduction

In report R443D (ref. 1) of the former Wind Energy Group of the University of Technology Eindhoven, about eighty airfoils are assembled which have been measured for low Reynolds numbers. A problem with this report is that it is no longer available and that most of the given airfoil graphs are too small for use in rotor blade calculations. Fortunately the original measuring points are given for almost all airfoils and using these points, new accurate graphs can be made.

Airfoils with a flat lower side are of interest for windmill rotor blades, especially if they are manufactured from massive wood. The Gö 623 airfoil which has a maximum thickness of 12 % of the chord is used in all my present VIRYA-windmills with wooden blades. The characteristics and geometry of this airfoil are given in my report KD 35 (ref. 2). Sometimes thinner or thicker airfoils are needed. The four airfoils Gö 622, Gö 623, Gö 624 and Gö 625 with thickness/chord ratios of respectively 8 %, 12 %, 16 % and 20 % have originally been measured by Riegels (ref. 3). These measurements are also given in R445D (ref. 1). The C_l - α and C_l - C_d curves are generally given for three Reynolds values at page 3-70 of R445D. Tables with measuring points are given at page 3-72 of R445D but only for two values of Reynolds $1.1 * 10^5$ (or $1.2 * 10^5$) and $4.2 * 10^5$ (except for the Gö 625 which has been measured for many Reynolds values). The curves for $2.2 * 10^5$ (or $2.3 * 10^5$) are estimated by copying the given curves as accurate as possible.

2 The Gö 622, Gö 623, Gö 624 and Gö 625 airfoil geometry

The airfoil geometry for all four airfoils is copied from the tables given on page 3-76 of R445D. The distance x is the value from the airfoil nose for an airfoil with a chord of 100 mm. The distance y_u is the corresponding value for the upper part of the airfoil. The distance y_l is the corresponding value for the lower part of the airfoil.

x (mm)	Gö 622		Gö 623		Gö 624		Gö 625	
	y_u (mm)	y_l (mm)						
0	2.40	2.40	3.25	3.25	4.00	4.00	5.50	5.50
1.25	3.75	1.45	5.45	1.95	7.15	2.25	9.00	3.30
2.5	4.50	1.05	6.45	1.50	8.50	1.65	10.80	2.35
5.0	5.45	0.60	7.90	0.90	10.40	0.95	13.30	1.25
7.5	6.15	0.35	9.05	0.35	11.75	0.60	14.95	0.75
10	6.60	0.25	9.90	0.20	12.85	0.40	16.35	0.40
15	7.30	0.15	10.95	0.10	14.35	0.15	18.25	0.15
20	7.70	0.05	11.55	0.05	15.30	0.05	19.30	0.10
30	8.00	0	12.00	0	16.00	0	20.00	0
40	7.80	0	11.70	0	15.40	0	19.05	0
50	7.10	0	10.65	0	14.05	0	17.35	0
60	6.15	0	9.15	0	12.00	0	15.05	0
70	5.00	0	7.35	0	9.50	0	12.10	0
80	3.55	0	5.15	0	6.60	0	8.60	0
90	1.95	0	2.80	0	3.55	0	4.75	0
95	1.15	0	1.60	0	2.00	0	2.75	0
100	0.20	0	0.30	0	0.50	0	0.65	0

table 1 Geometry of the Gö 622, Gö 623, Gö 624 and Gö 625 airfoils for a chord $c = 100$ mm

The y_u -values for $x = 100$ are very small. Sometimes the airfoil tailing edge is taken somewhat thicker to prevent damage of the blades during transport. It is expected that the effect of this increase of the thickness on the airfoil characteristics, can be neglected.

It may be expected that the airfoil thickness of a thicker airfoil is found by multiplying the y -factors of a thinner airfoil by a certain value but this is not true as the y -value of the Gö 624 for $x = 0$ is not exactly double the y -value of the Gö 622. The four airfoils are given on scale in figure 1, 2, 3 and 4.

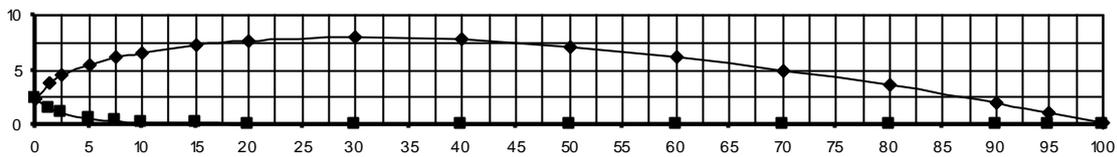


fig. 1 Gö 622 airfoil for $c = 100$ mm

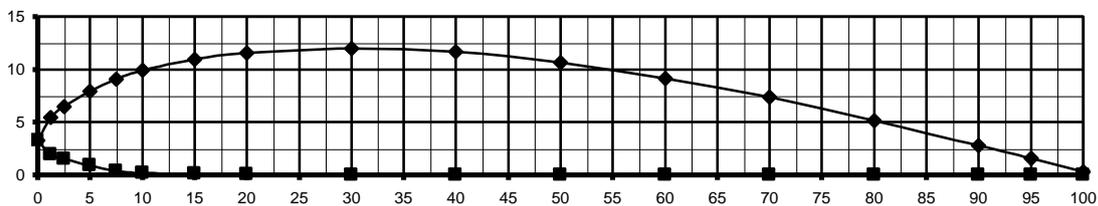


fig. 2 Gö 623 airfoil for $c = 100$ mm

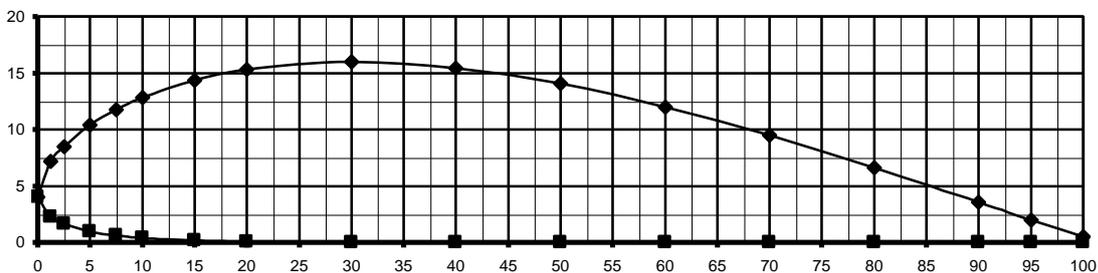


fig. 3 Gö 624 airfoil for $c = 100$ mm

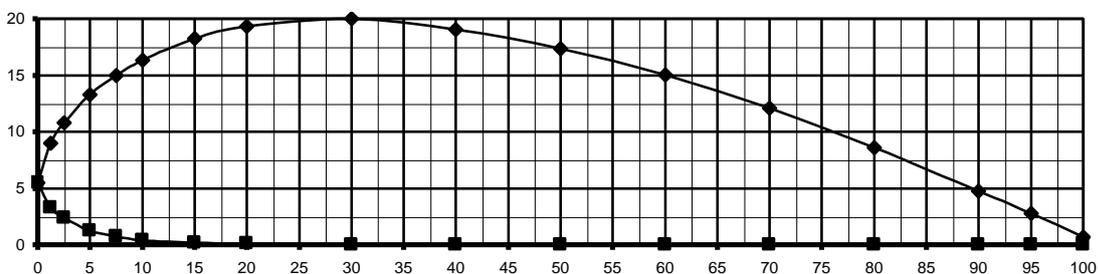


fig. 4 Gö 625 airfoil for $c = 100$ mm

If the real blade chord c is a factor i larger than 100 mm, all the x -values and y -values of figure 4 have to be multiplied by the same factor i . The strength of a beam is determined by the moment of resistance W which is proportional to the thickness h^2 . The ratio of the strength of the four airfoils with the same chord is therefore 1 : 2.25 : 4 : 6.25. The thicker airfoils are normally only used near the blade root because the bending moment is largest there.

3 The Gö 622, Gö 623, Gö 624 and Gö 625 airfoil characteristics

The C_l - α curves are given in figure 5, 7, 9 and 11. The C_l - C_d curves are given in figure 6, 8, 10 and 12. α is the angle of attack. C_l is the lift coefficient. C_d is the drag coefficient. The moment coefficient C_m around the quart chord point was also measured by Riegels for some airfoils and for some Reynolds values. But for the calculation of the geometry of a windmill rotor, only the C_l - α and the C_l - C_d curves are of interest and so the C_m - α curves are not given.

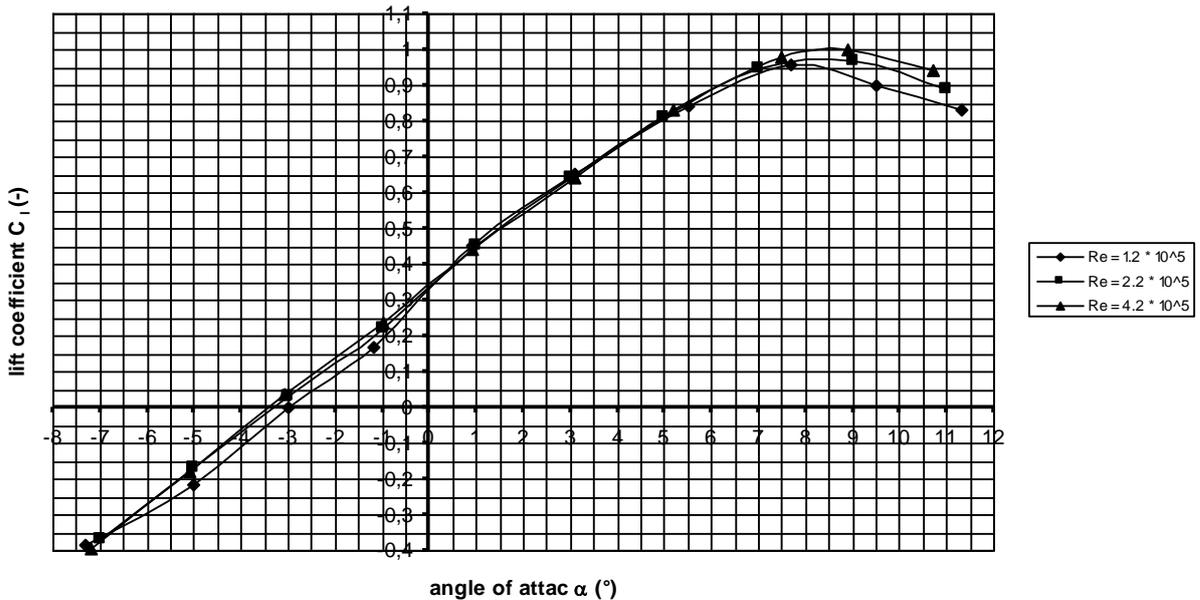


fig. 5 C_l - α curves for the Gö 622 for $Re = 1.2 \cdot 10^5$, $2.2 \cdot 10^5$ and $4.2 \cdot 10^5$

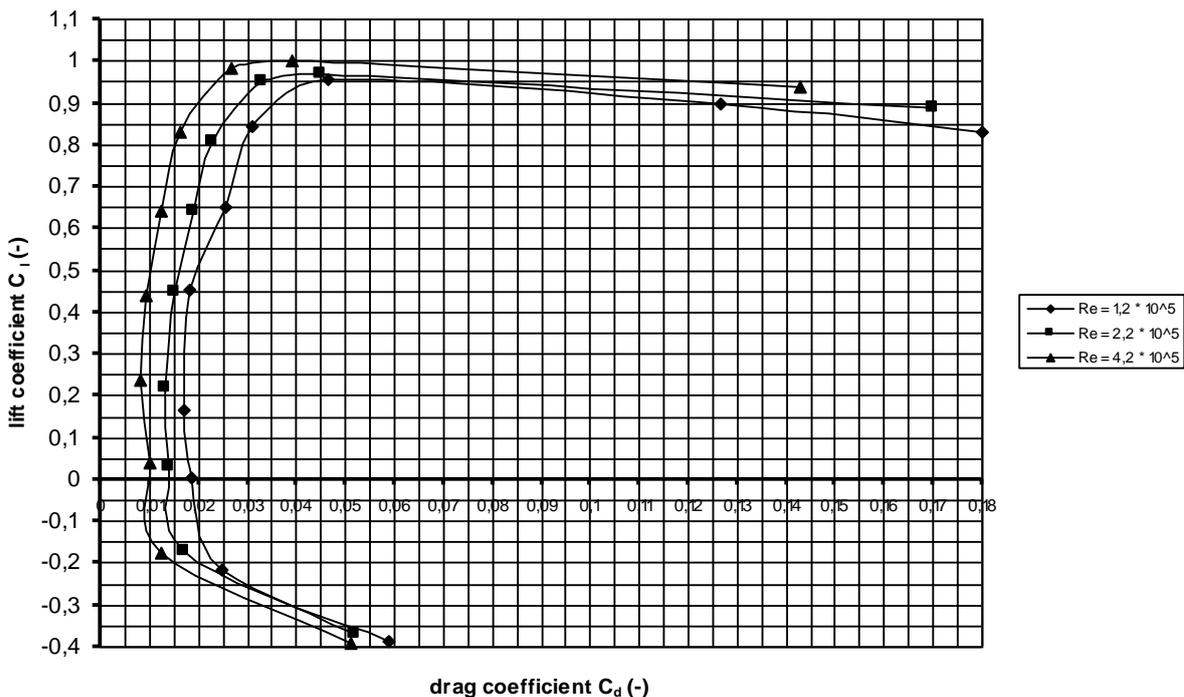


fig. 6 C_l - C_d curves for the Gö 622 for $Re = 1.2 \cdot 10^5$, $2.2 \cdot 10^5$ and $4.2 \cdot 10^5$

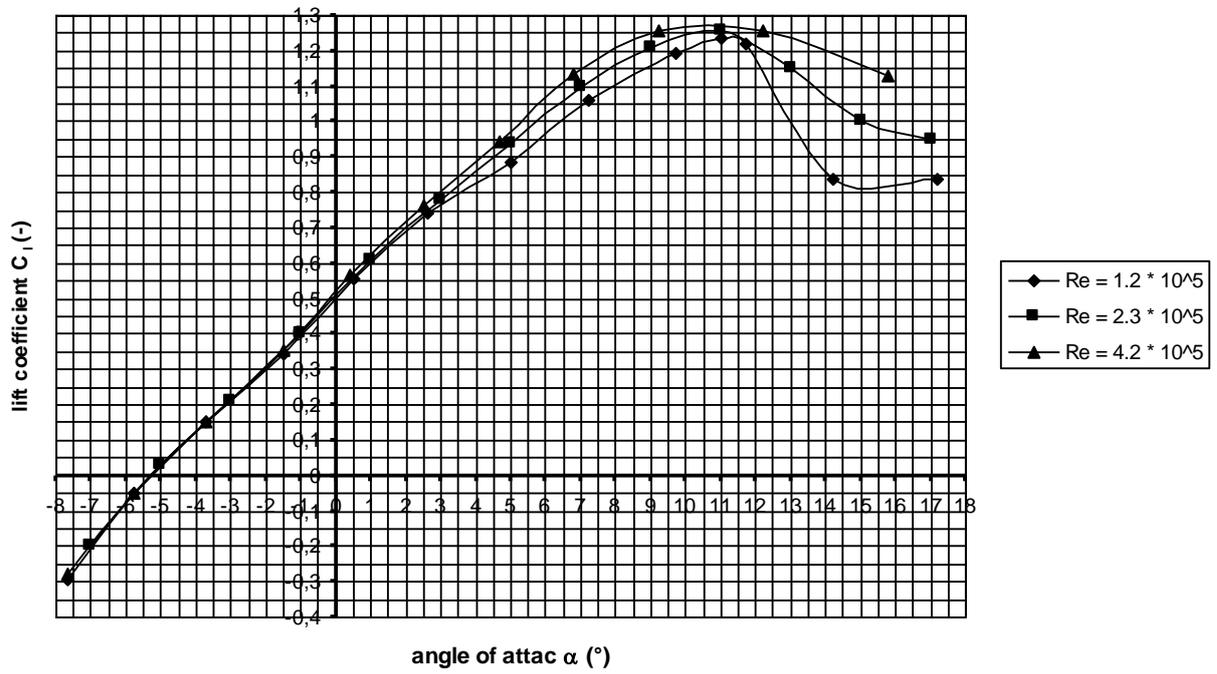


fig. 7 C_l - α curves for the Gö 623 for $Re = 1.2 \cdot 10^5$, $2.3 \cdot 10^5$ and $4.2 \cdot 10^5$

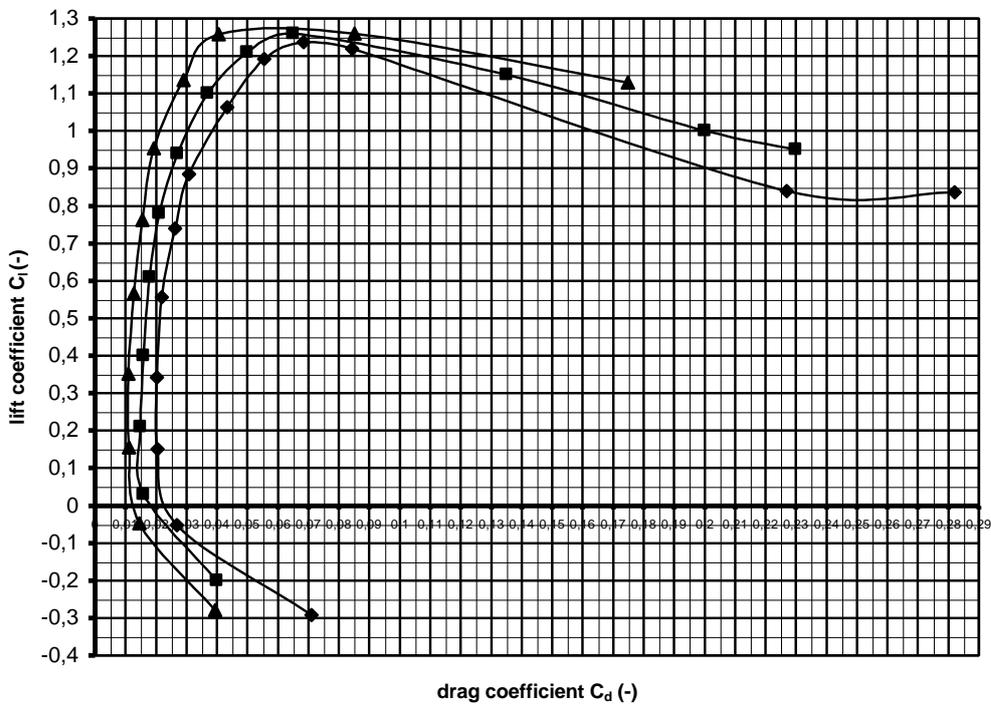


fig. 8 C_l - C_d curves for the Gö 623 for $Re = 1.2 \cdot 10^5$, $2.3 \cdot 10^5$ and $4.2 \cdot 10^5$

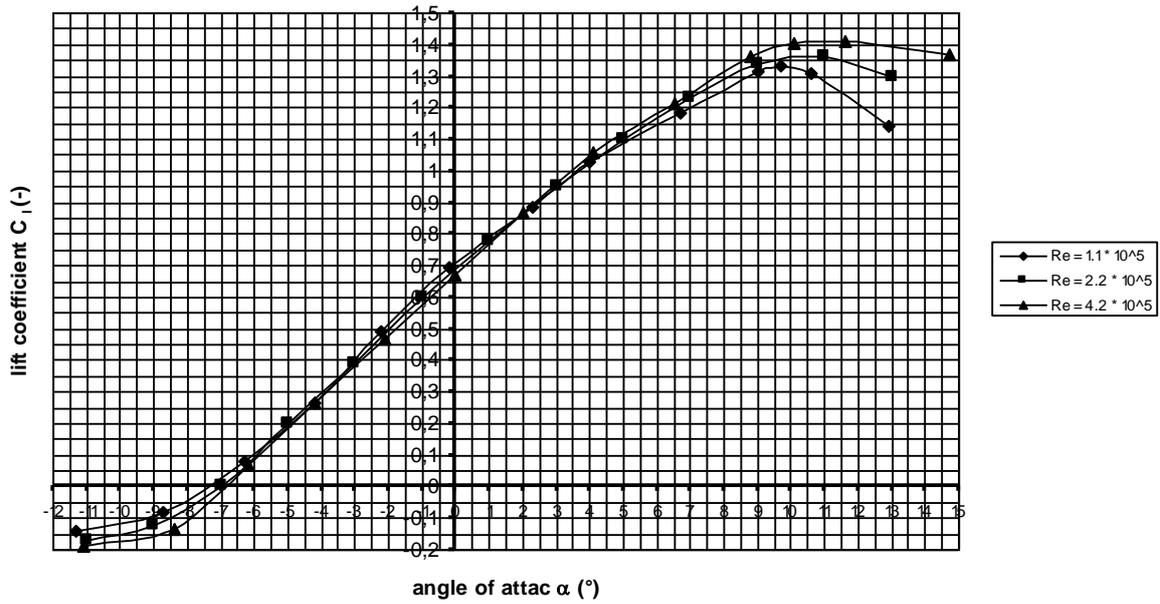


fig. 9 C_l - α curves for the Gö 624 for $Re = 1.1 \cdot 10^5$, $2.2 \cdot 10^5$ and $4.2 \cdot 10^5$

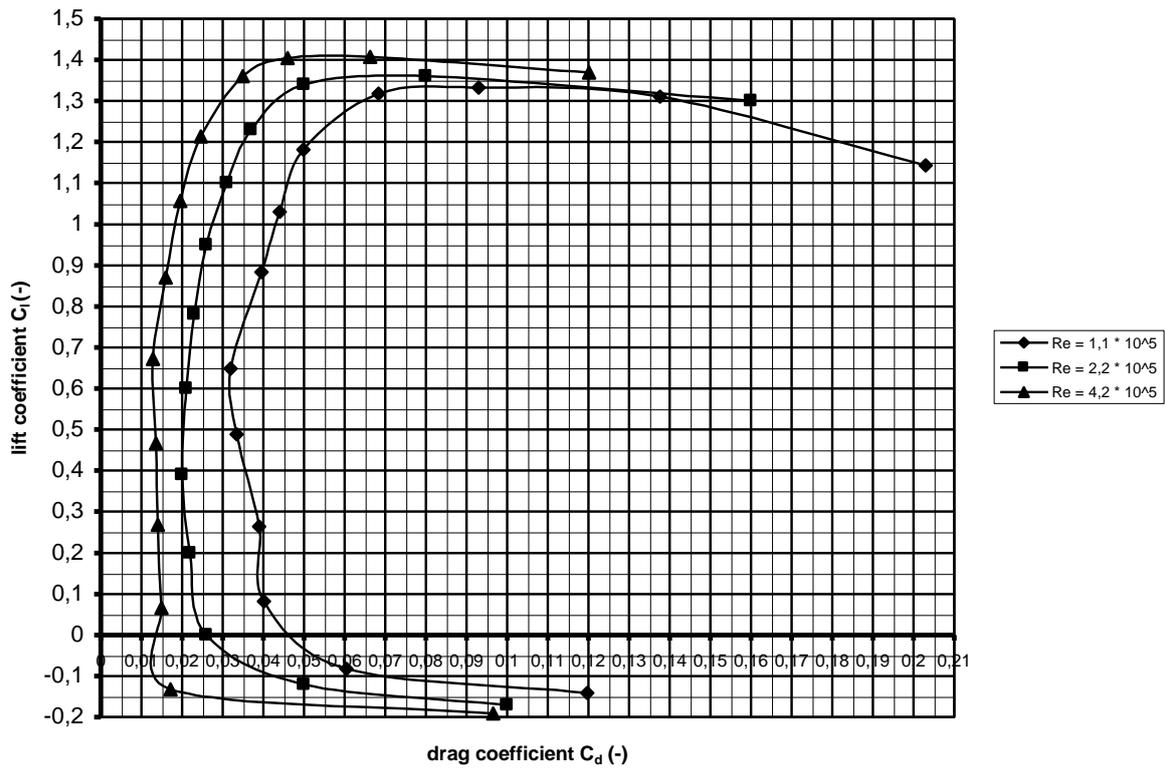


fig. 10 C_l - C_d curves for the Gö 624 for $Re = 1.1 \cdot 10^5$, $2.2 \cdot 10^5$ and $4.2 \cdot 10^5$

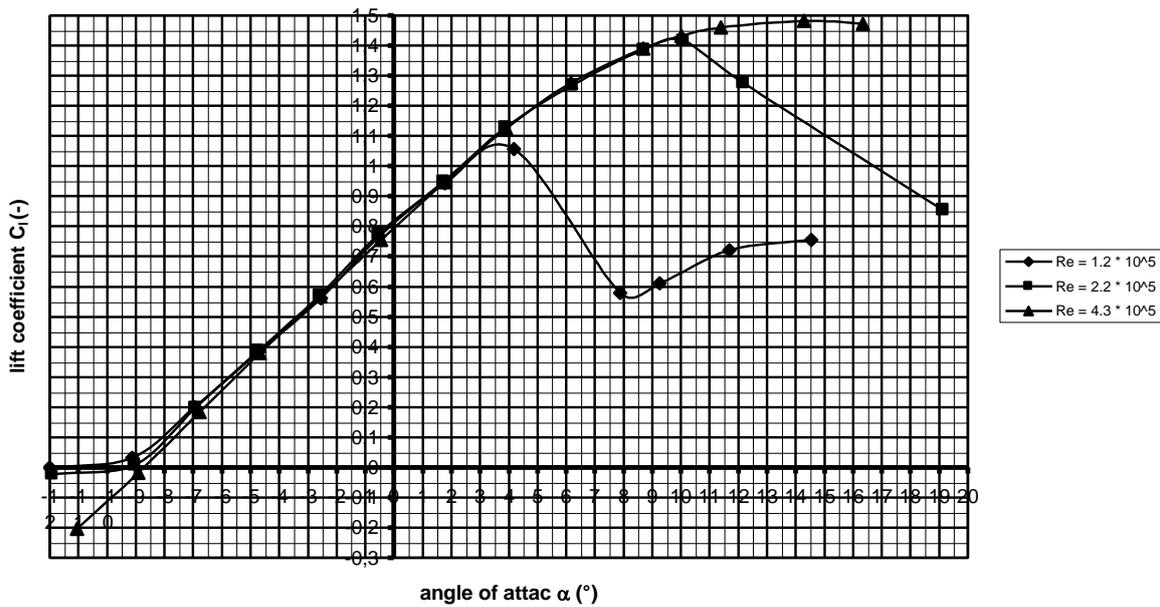


fig. 11 C_l - α curves for the Gö 625 for $Re = 1.2 \cdot 10^5$, $2.2 \cdot 10^5$ and $4.3 \cdot 10^5$

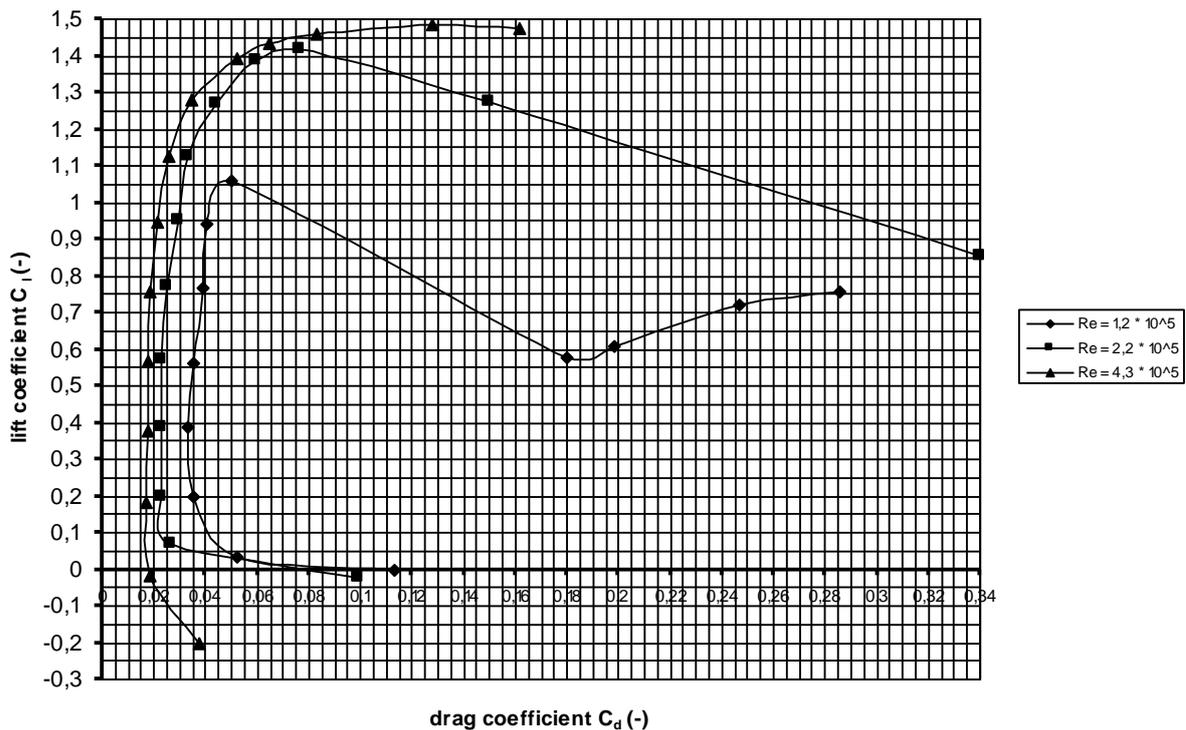


fig. 12 C_l - C_d curves for the Gö 625 for $Re = 1.2 \cdot 10^5$, $2.2 \cdot 10^5$ and $4.3 \cdot 10^5$

In figure 11 it can be seen that the Gö 625 airfoil is stalling at rather low values of α for low Reynolds values. Stalling means that the C_l -value drops suddenly at increasing α .

The minimum C_d/C_l ratio for a certain Reynolds value is found by drawing a line through the origin which touches the C_d - C_l curve for that Reynolds value. This line intersects with the line $C_l = 1$. The C_d value for the point of intersection is the minimum C_d/C_l ratio. The thinnest airfoils have the lowest minimum C_d/C_l ratio for the highest Reynolds value.

4 References

- 1 Hageman A. Catalogue of Aerodynamic Characteristics of Airfoils in the Reynolds number range $10^4 - 10^6$, July 1980, Report R443D (no longer available), Laboratory of Fluid Dynamics and Heat Transfer, Department of Physics, University of Technology Eindhoven.
- 2 Kragten A. Rotor design and matching for horizontal axis wind turbines, January 1999, latest review November 2015, free public rapport KD 35, engineering office Kragten Design, Populierenlaan 51, 5492 SG Sint-Oedenrode, The Netherlands.
- 3 Riegels F. W. Aerodynamische Profile (in German), Oldenbourg, R. München, 1958.