



Designing a Kiteboard Hydrofoil Wing: Fluid Flow



Structural and Fluid Analysis

ACMA6010

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AI Acknowledgement

I confirm that I have not used any AI tools in the research and creation of this assignment. I confirm that I have not presented any AI generated materials as my own work.

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1. Introduction

This report will assess and critically appraise the fluid flow around the structure of a kiteboard hydrofoil, the report will investigate Reynolds number, analyse boundary flow around the hydrofoil, discussing the design of the wing, critically appraise forces, investigate how carbon fibre reinforced plastic may effect the performance of the hydrofoil, analyse any modelling techniques that could be used to simulate fluid flow and if a prototype was to be produced how data should be obtained and compared to the simulation.

2. Task 1

2.1 What is Reynolds Number?

Reynolds number is named after British physicist Osbourne Reynolds, a dimensionless quantity and is the ratio between the inertial and viscous forces in a fluid (Bhuyan, 2023). According to (What is a Reynolds Number? [no date]) it is used to determine the type of flow, be it laminar flow or turbulent flow, ('What Is the Reynolds Number and Why Is It Important?'. , 2025a) suggests that Reynolds number determines whether the fluid movement will be smooth and orderly or unpredictable. When the Reynolds number is less than 2000 it is considered laminar flow, greater than 2000 flow is generally turbulent. The distinction between laminar and turbulent flow isn't a specific value but can be between a range of values (*Reynolds number | Definition & History | Britannica*, 2025). ('What is Reynolds Number for Turbulent Flow - Definition'. , 2019) states that if Reynolds number is less than 2000 it is laminar flow, however a Reynolds number between 2000 to 4000 is classed as transitional flow, as the flow is unstable from the onset of turbulence and if the Reynolds number is greater than 3500 the flow is turbulent.

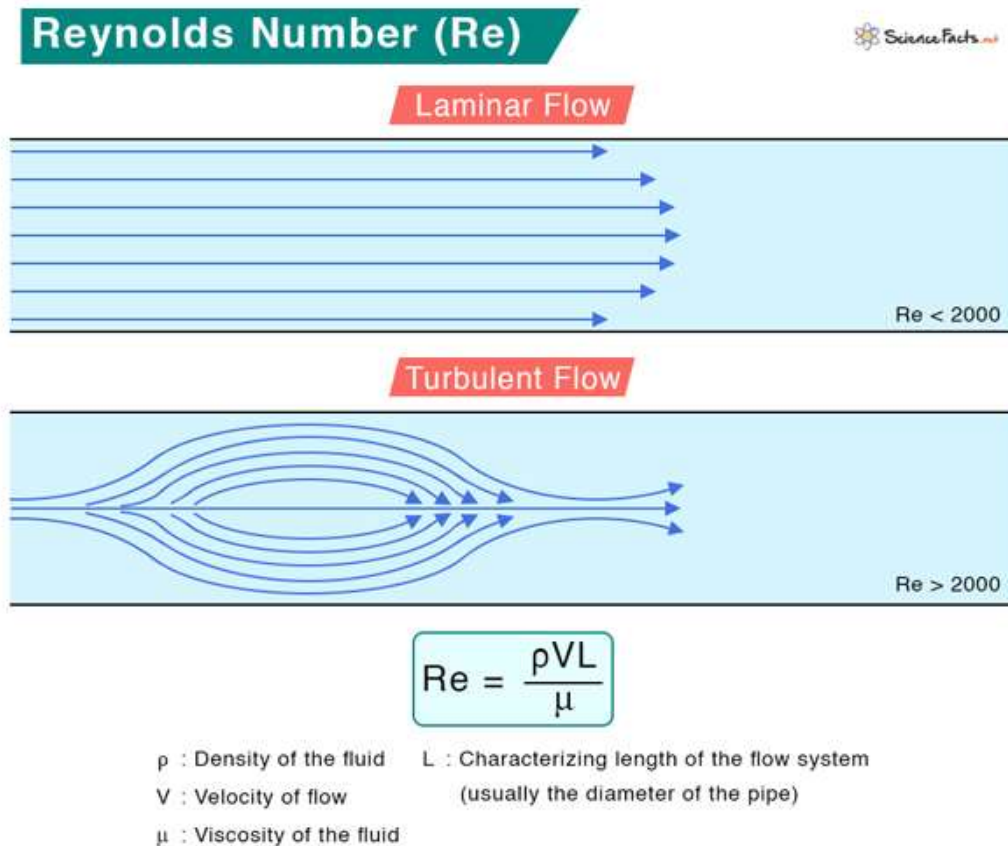


Figure 1 - Laminar And Turbulent Flow And Reynolds Equation (Bhuyan, 2023)

Figure 1 shows the Reynolds number can be calculated by multiplying the density of the fluid, the velocity of the flow and the length usually the diameter of the pipe, and dividing by the viscosity of the fluid.

To estimate the Reynolds number-

Density of seawater can be taken as – 1028 kg/m³ in water temperature of 4 degrees (*Seawater - Properties*, [no date]).

Velocity of kiteboard – 10.28m/s – As kiteboards can reach speeds of 23mph to 46mph ('Hydrofoil Top Speed: Fast 111KM/H!', 2023)

Chord length – 0.1m

Viscosity of fluid - 0.00167 (Ns/m², Pa s) in sea water temperature of 4 degrees (*Seawater - Properties*, [no date])

$$Re = \frac{1028 \times 10.28 \times 0.1}{0.00167} = 632804.7904$$

With the result of this equation being over 2000 it would be a suggestion that it would be turbulent flow around the hydrofoil kiteboard wing.

2.2 Why Is Reynolds Number Important?

Knowing the Reynolds number allows for comparisons of flow conditions across different fluids, scales and situations the resulting number allows to determine the fluid flow around the object ('What Is the Reynolds Number and Why Is It Important?', 2025b). With regards to the hydrofoil wing, varying Reynolds number will determine how the hydrofoil reacts. Identifying the Reynolds number and so determining the flow, the Reynolds number can provide an advantage for engineers during designs (*What Is Reynolds Number and Why Is It Important?*, [no date]). Hydrofoil wing design can change significantly, influencing the stability, speed and manoeuvrability on the water, different aspect ratios, foil range and material construction can be some of the differences in design, wings with a higher aspect ratio offer enhanced lift and efficiency (Paulson, 2025). Different designs affect how the hydrofoil moves through the water, this will be down to how the fluid flows across the wing.

3. Task 2

3.1 Boundary Flow Around The Hydrofoil

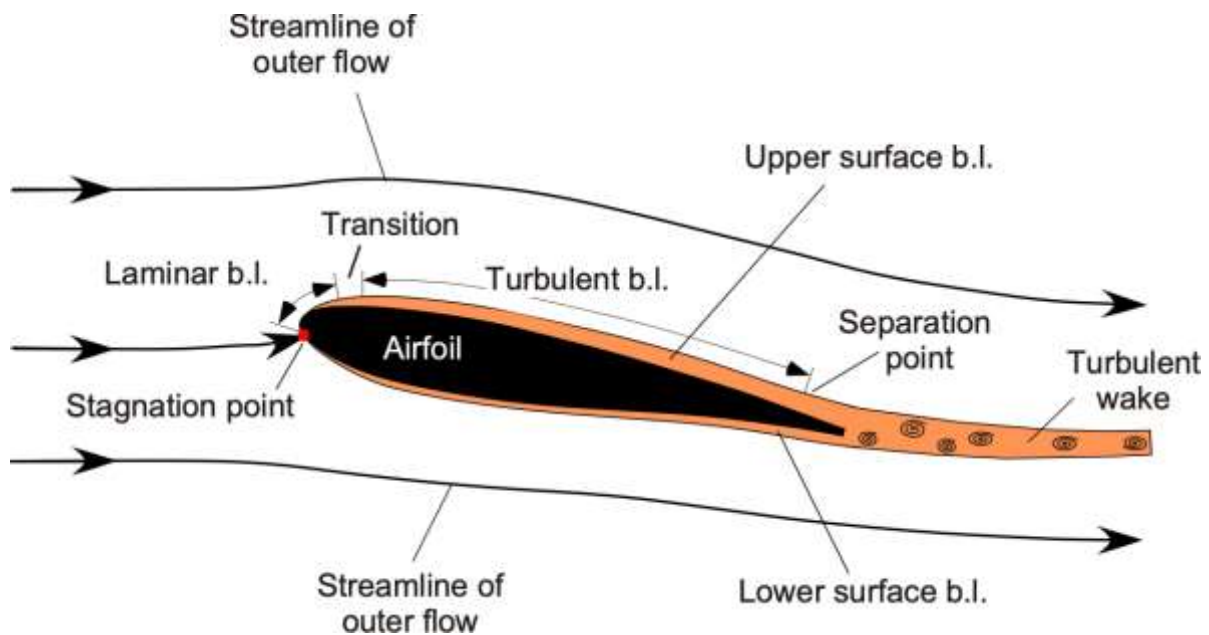


Figure 2 Boundary Layers Developing Over Upper And Lower Foils (Leishman, 2023b)

Figure 2 displays a diagram of boundary layers. Flow moving from the left-hand side of the diagram to the right, hits the foil at the stagnation point. The stagnation point is a dividing point where flow hits the airfoil, and has neither gone over nor under the foil. The degree of camber, the curvature of upper surface compared with the lower surface, determines the location of the stagnation point to sit lower on the leading edge. There is also a rear stagnation point where the molecules rejoin after parting at the forward stagnation point. ('2018-stagnation-point-and-icing.pdf', [no date]). After the flow initially hits the stagnation point the boundary layer develops. The boundary layer is a thin layer of fluid that clings to the surface of an object moving through fluid ('The Boundary Layer and Wing Design: Aerodynamics - Aviation Gurukul, GOLN', 2018). It starts as a laminar flow, transitions to turbulent flow the further along the foil (Leishman, 2023b). Pressure gradient moving over the airfoil decreases from left to right in the direction of fluid flow. With pressure gradient decreasing as it moves across the foil this encourages the fluid flow in the same direction, however a shearing action in the boundary layer is trying to slow the fluid down, forcing the fluid to stay attached this is up to the shoulder of airfoil. Once the fluid flows over the shoulder of the airfoil and the height starts to decrease the pressure changes and starts to increase, so resisting the flow is the pressure increase as well as viscosity of the fluid. When the velocity in the boundary layer reaches zero separation occurs, due to the pressure gradient, velocity of fluid reverses producing the turbulent wake. Flow separation affect the airfoil by reducing lift and increasing drag (Leishman, 2023b). The transition point depends on the Reynolds number, surface condition and disturbances. As the fluid flows over the airfoil the boundary layer thickens in the streamwise direction, it is an important factor in determining the flow and pressure distribution over the airfoil. The characteristics of the boundary layer depend on the Reynolds number. Higher Reynolds number, where inertial effects are stronger than viscous effects, boundary layers are thin, robust and stay attached to surfaces over longer distances, however a lower Reynolds number, the boundary layers

are thicker, slower and prone to separation (Leishman, 2023b). According to ('The Boundary Layer and Wing Design: Aerodynamics - Aviation Gurukul, GOLN'. , 2018) the shape of the airfoil influence how the boundary layer develops, a symmetrical shape may not produce lift at a zero angle of attack. Cambered airfoils however can produce lift without an angle of attack. The two types of boundary layer are laminar and turbulent, laminar is a smooth flow with low drag but easily disrupted, turbulent is chaotic swirling flow, creating friction and more drag, but is less prone to separation ('The Boundary Layer and Wing Design: Aerodynamics - Aviation Gurukul, GOLN'. , 2018). The important part of the Kiteboard Hydrofoil will be the design of the airfoil, the top surface of an airfoil is often more convex than the bottom, creating pressure difference above and below the airfoil resulting in lift. The camber is often designed for maximizing the lift coefficient, there is a range of designs (*Cambered Airfoil Explained: The Effects of Shape on Lift*, [no date]). Correct design and camber of the airfoil can generate lift, important for the kiteboard to raise out of the water. The principle on how this works is the Bernoulli principle, the airfoil having similar affect to a venturi tube. When flow travels around the airfoil, the pressure above the airfoil is low, whereas pressure below the airfoil is higher this pressure difference causes upward force and so lift (*Aerodynamics*, [no date]). This lift, lifts the board out of the water, when travelling. The wing has to be designed in a way to produce lift otherwise the kiteboard would sit on the water surface.

4. Task 3

During assignment 1 the forces acting on the wing were 500N vertically at the centre of each side of the wing, the assumed force of 500N can be analysed in the following ways. According to (Team, 2024) the lift force counteracts the weight of the hydrofoil allowing the hydrofoil to rise above the surface of the water. Lift force has to be able to counter act and lift the 500N downward force, with the overall downward force assumed to be 1000N. Using a converting tool, 500N converts to 50.98Kilograms (*500 Newtons to kg - Convert 500 Newtons to Kilograms*, [no date]). Taking this value of 50.98kg and multiplying it by two equals the total downward weight of 101.96Kg. This is a very generally weight, as two factors contributing to this are the weight of the human riding the board and the board itself. Supporting this is (philipp4u2, 2022) considers that the weight of the rider as well as the setup contribute to the weight force, with the lift force counteracting this. With regards to the board (*How to Pick a Hydrofoil Wing | Barts.com*, 2025) suggests that there are several different hydrofoil characteristics to consider, the surface area of the board comes down to two factors the riders weight and the riding style, a beginner rider may have a larger surface area board, which may be slower, but an advanced rider may have a smaller surface area board to maximize handling and speed. ('Wing Foil Buyers Guide: Boards, Foils & Wing Sizes', 2025) also suggest that rider weight and rider experience plays a role in board size. Different size boards will correspond to different weights. (Team, 2025) advises that there is link between rider weight, skill level, and board length, supporting ('Wing Foil Buyers Guide: Boards, Foils & Wing Sizes', 2025). With different types of board and sizes available which correspond to a riders weight and skill level it is hard to determine the actual weight of a hydrofoil board. Another factor contributing to the overall weight acting downwards would be the riders weight, with many variables, as humans weigh differently. The assumption 101.96Kg could be consider a random figure however the mean weight of men and women in 2021 were 85.1kg and 71.8kg respectively according to a health survey in England (*Part 4: Trends*, [no date]). Using these figures and allowing for the weight of the board, plus additional items wetsuit, kite, attachments the weight of 101.96 potentially isn't unrealistic and could be used as a guide. (*Tutorial construction of wings or foils initiation*, [no date]) indicates that when making a hydrofoil a weight of a small boat and its driver is 100kg and lift force equals the weight roughly 1000 Newtons. Although this article is comparing a small boat and making general assumptions so not reliable it however does produce similar figures of forces just by making general assumptions.

The force required to lift up the hydrofoil using the formula $F = m \times g$

Where:

- F = Force (N)
- m = Mass (kg)
- g = Gravity (9.81 m/s^2)

To lift 101.96 kg:

$F = 101.96 \times 9.81 = 1000.23\text{N}$ the force required to lift hydrofoil

The force acting onto to the hydrofoil would come from the fluid, (Leishman, 2023a) indicates that aerodynamic forces are directly proportional to the dynamic pressure in the flow, which is the pressure associated with the fluids kinetic energy. Dynamic pressure comes from the flow density and its velocity. Although there is the weight of the rider and board, the fluid is the pressure onto the wing itself. The forces onto the airfoil system can be investigated in two different systems the wind-axis system for lift and drag and chord- axis system, normal force and chord force. With the airfoil being a curved shape, an approximation could be done with the force acting centrally as with curvature, forces may act different across the airfoil, the force acting vertically downward could be an assumption as force will move over the curvature of the wing whilst travelling through the fluid. The force of the fluid cannot be applied to a single area as the fluid force would act and distribute itself all over the airfoil wing.

5. Task 4

Material selection is critical for the performance and longevity of the component historically high strength aluminium alloys, stainless steel, fibre reinforced polymers, titanium alloys have been used (Lee, [no date]). Material choice often depends on application, considerations including cost, weight and durability, other considerations may include accessibility of materials, manufacturing costs and feasibility. Carbon Fibre Reinforced Plastics (CFRP) have been used across many industries due to its high specific stiffness and strength and anisotropic properties, in the marine environment composite materials have the potential to eliminate and lower galvanic corrosion as well as reduce weight (Liu and Young, 2009). A study carried out on hydrofoils for boats by (Zhang et al., 2024) investigated hydrodynamic performance of flexible hydrofoils. Finding showed flexible hydrofoils have a certain propulsive advantage over rigid hydrofoils however (Alam et al., 2019) states that CFRP are an advantageous material in engineering because of its high strength to weight ratio. CFRP stiffness and strength properties with regard to weight are greater than other materials such as polymers, metals, alloys, and foams. However (Alam et al., 2019) also states that the lack of repeatability of CFRP in fatigue is a concern and results show considerable scatter when it comes to fatigue testing. A study by (Zarruk et al., 2014) into composite and metal hydrofoils found that composite hydrofoils experienced much larger deflection and twist deformations under hydrodynamic loading. With twist angle dependence on orientation of carbon layers. Findings of (Kapoor, [no date]) suggests that a key advantage of composites material is the high strength to weight ratio allowing for effective lift while minimizing resistance. The use of composite materials offer design flexibility, for different performance characteristics with composites being able to be moulded into complex shapes (Kapoor, [no date]) also highlights some of composites disadvantages being they are susceptible to damage, they cost more than other materials, and repairs to parts are not easily carried out. Compared to aluminium, carbon fibres lightweight properties may have improved performance qualities for the rider, however they have higher purchasing costs and are vulnerable to damage (Kapoor, [no date]). Similar to above references ('Advantages and Disadvantages of Carbon Fibre Reinforcement Polymer Free Essay Example', 2016) states that CFRP has advantages such as its strength to weight ratio and resistance to corrosion, but the disadvantages of brittleness damage if hit and high costs. With many of the references highlighting similar information over CFRP it seems to be clear in terms of material choice though CFRP has advantages over other material choices, it does in fact carry disadvantages, but seems to be rider preference, cost, and skill level on which to choose.

6. Task 5

Techniques used to simulate fluid flow around this hydrofoil could consist of the use of Computational Fluid Dynamics (CFD) simulations. CFD is the analysis of systems involving fluid flow (Malalasekera, H.K. Versteeg And W., 2007). CFD provides a means for solving fluid problems without analytical solutions, a means of simulating, analysing and optimizing designs. With advancement in computer technology, solutions to problems can be obtained, improvements in numerical algorithms have also helped in reducing costs. CFD techniques may provide advantages such as obtaining details about the flow field and opportunity to visually see object being examined under the test. Often experiments are carried out on the objects in line with CFD analyses to compliment the process (Yilmaz and Mwesigye, 2018). According to (M, 2025) however CFD modelling can reduce the needs for prototyping by up to 60% and increases design capacity. So, although simulations and experiments can be carried out alongside each other to complement each process CFD can also be used to reduce the needs for prototyping or reduce the amount of prototype modelling. However as (Yilmaz and Mwesigye, 2018) suggests running experiments of the model alongside the CFD analysis (Chowdhury, 2024) also highlights the importance of CFD validation, comparing simulation results with experimental data or analytical solutions to establish confidence in CFD models. (*Advantages and disadvantages of CFD | Quadco Engineering*, [no date]) suggests validation of a CFD model against experimental or physical data to be a disadvantage, as it can be time consuming and expensive as well as CFD modelling being Complex to set up and run.

There are different techniques with regards to CFD modelling some of the techniques can consist of :

Mesh optimisation strategies for complex geometries – these can consist of adaptive mesh refinement, boundary layer mesh techniques.

Turbulence modelling at scale – Renolds – Averaged Navier – Stokes model selections (M, 2025).

One of the models consisting of the Shear Stress Transport (SST) model which is a combination of K-Omega and K-Epsilon turbulence models known for simulating turbulent flow in boundary layers (*SST k-omega model -- CFD-Wiki, the free CFD reference*, [no date]) also suggests that responds well in adverse pressure gradients and separating flow.

With many applications of software there are advantages and disadvantages associated with them, when it comes to CFD modelling (*Advantages and disadvantages of CFD | Quadco Engineering*, [no date]) states that some of the advantages can be-

Costs savings, increased accuracy, better visualisation, visual prototyping. CFD can save time and money compared to traditional methods (*Advantages and disadvantages of CFD | Quadco Engineering*, [no date]). (Refaie Ali et al., 2024) states that when CFD is coupled with artificial neural networks (ANNs) a significant reduction in computing time has been noticed compared with CFD simulations only, supporting (*Advantages and disadvantages of CFD | Quadco Engineering*, [no date]) costs saving statement, as less computer time means less time spent on the activity saving money on labour. ('Pros-and-Cons-of-CFD-and-Physical-Flow-Modeling.pdf', [no date]) also support the money saving aspect of CFD modelling as it states that CFD model studies are 20-40% less than a physical model.

7. Task 6

This experiment could be carried out in the following ways-

Firstly a prototype model could be made, and then carry out tests on the prototype. ('Cedarville-Univ-Submission-for-posting.pdf', [no date]) built a hydrofoil prototype and then conducted numerous tests, with tests being carried out on a lake. (Serra, 2019) conducted a report into the designing and construction of a hydrofoil and as part of this prototypes were constructed and tested before a full scale prototype was made. Tests of these studies were carried out on open water, where as (Simonet et al., 2024) experimental study on dynamic stall of rigid and flexible hydrofoils carried out experiments in a towing tank. Similar to this (Boyd, 2018) writes about towing tank testing of a model scale sailing hydrofoil. The use of wind tunnels could be used to view how the airfoil reacts to flow passing over it, however (Author, 2024) report suggests that wind tunnel wall interference can happen and refers to the alterations in airflow characteristics around a test model. When data and results have been collected from prototype experiments, the data can be compared to that of the CFD modelling.

8. References

- 500 Newtons to kg - Convert 500 Newtons to Kilograms* ([no date]). Available at: <https://freeunitconvert.com/en/weight/n-to-kg/500/> (Accessed: 29 November 2025).
- '2018-stagnation-point-and-icing.pdf'. ([no date]). Available at: <https://peter-ftp.co.uk/aviation/misc-euroga/2018-stagnation-point-and-icing.pdf> (Accessed: 28 November 2025).
- 'Advantages and Disadvantages of Carbon Fibre Reinforcement Polymer Free Essay Example'. (2016) *StudyMoose* 15 October. Available at: <https://studymoose.com/advantages-and-disadvantages-of-carbon-fibre-reinforcement-polymer-essay> (Accessed: 29 November 2025).
- Advantages and disadvantages of CFD | Quadco Engineering* ([no date]). Available at: <https://www.quadco.engineering/en/know-how/cfd-advantages-and-disadvantages.htm> (Accessed: 30 November 2025).
- Aerodynamics* ([no date]). Available at: <https://www.grc.nasa.gov/WWW/K-12/WindTunnel/Activities/aerodynamic.htm> (Accessed: 29 November 2025).
- Alam, P., Mamalis, D., Robert, C., Floreani, C. and Ó Brádaigh, C.M. (2019) 'The fatigue of carbon fibre reinforced plastics - A review'. *Composites Part B: Engineering* 166, pp. 555–579. Available at: doi:10.1016/j.compositesb.2019.02.016.
- Author (2024) 'Wind Tunnel Wall Interference: Understanding and Mitigating Its Effects on Aerodynamic Testing'. *Diverse Daily* 15 August. Available at: <https://diversedaily.com/wind-tunnel-wall-interference-understanding-and-mitigating-its-effects-on-aerodynamic-testing/> (Accessed: 30 November 2025).
- Bhuyan, S. (2023) 'Reynolds Number: Definition, Equation, and Solved Problem'. *Science Facts* 12 April. Available at: <https://www.sciencefacts.net/reynolds-number.html> (Accessed: 27 November 2025).
- Boyd, S. (2018) *Experimental testing of sailing hydrofoils | Maritime Engineering and Ship Science*. Available at: <https://generic.wordpress.soton.ac.uk/maritimeblog/2018/04/11/experimental-testing-of-sailing-hydrofoils/> (Accessed: 30 November 2025).
- Cambered Airfoil Explained: The Effects of Shape on Lift* ([no date]). Available at: <https://resources.system-analysis.cadence.com/blog/msa2022-cambered-airfoil-explained-the-effects-of-shape-on-lift> (Accessed: 29 November 2025).
- 'Cedarville-Univ-Submission-for-posting.pdf'. ([no date]). Available at: <https://foils.org/wp-content/uploads/2019/10/Cedarville-Univ-Submission-for-posting.pdf> (Accessed: 30 November 2025).
- Chowdhury, I. (2024) 'State-of-the-Art CFD Simulation: A Review of Techniques, Validation Methods, and Application Scenarios'. *ResearchGate*. Available at: doi:10.46610/JoRTM.2024.v09i02.005 (Accessed: 30 November 2025).
- How to Pick a Hydrofoil Wing | Barts.com* (2025). Available at: <https://www.barts.com/blogs/news/how-to-pick-a-hydrofoil-wing> (Accessed: 29 November 2025).

<https://byjus.com/physics/reynolds-number/> ([no date]). Available at:
<https://byjus.com/physics/reynolds-number/> (Accessed: 27 November 2025).

‘Hydrofoil Top Speed: Fast 111KM/H!’. (2023) 18 September. Available at:
<https://www.unitysurf.com/hydrofoil-top-speed/> (Accessed: 27 November 2025).

Kapoor, R. ([no date]) *Hydrofoil Board Wings: Design and Performance Insights*. Available at:
<https://windsrider.com/articles/hydrofoil-board-wings-performance-insights/> (Accessed: 29 November 2025).

Lee, S. ([no date]) *Hydrofoil Design Essentials*. Available at:
<https://www.numberanalytics.com/blog/hydrofoil-design-essentials> (Accessed: 29 November 2025).

Leishman, J.G. (2023a) ‘Aerodynamics of Airfoil Sections’. Available at:
doi:10.15394/eaglepub.2022.1066.n23 (Accessed: 29 November 2025).

Leishman, J.G. (2023b) ‘Boundary Layer Flows’. Available at: doi:10.15394/eaglepub.2022.1066.n22
(Accessed: 28 November 2025).

Liu, Z. and Young, Y.L. (2009) ‘Utilization of bend–twist coupling for performance enhancement of composite marine propellers’. *Journal of Fluids and Structures* 25(6), pp. 1102–1116. Available at:
doi:10.1016/j.jfluidstructs.2009.04.005.

M, F. (2025) ‘CFD Modelling: 5 Techniques Every Engineer Must Know’. *CFD Solutions* 8 May.
Available at: <https://flowtechdynamics.com/cfd-modelling-for-engineers/> (Accessed: 30 November 2025).

Malalasekera, H.K. Versteeg And W. (2007) *An introduction to computational fluid dynamics: the finite volume method*. Available at: <https://r4-vlebooks-com.ezproxy.uwtsd.ac.uk/Reader?ean=9781405891042#> (Accessed: 30 November 2025).

Part 4: Trends ([no date]). Available at: <https://digital.nhs.uk/data-and-information/publications/statistical/health-survey-for-england/2021/part-4-trends> (Accessed: 29 November 2025).

Paulson, B. (2025) ‘Hydrofoil Surfing Wings Explained: Which One Should You Use?’. *Paddleboard Surf: Having Fun On The Water* 1 November. Available at: <https://paddleboardsurf.com/hydrofoil-surfing-wings-explained-which-one-should-you-use/> (Accessed: 28 November 2025).

philipp4u2 (2022) ‘Physics of a Hydrofoil’. 7 April. Available at: <https://pumpfoilers.ch/en/physics-of-a-hydrofoil/> (Accessed: 29 November 2025).

‘Pros-and-Cons-of-CFD-and-Physical-Flow-Modeling.pdf’. ([no date]). Available at:
<https://www.airflowsciences.com/sites/default/files/docs/Pros-and-Cons-of-CFD-and-Physical-Flow-Modeling.pdf> (Accessed: 30 November 2025).

Refaie Ali, A., Mahmood, R., Asghar, A., Majeed, A.H. and Behiry, M.H. (2024) ‘AI-based predictive approach via FFB propagation in a driven-cavity of Ostwald de-Waele fluid using CFD-ANN and Levenberg–Marquardt’. *Scientific Reports* 14(1), p. 11024. Available at: doi:10.1038/s41598-024-60401-2.

Reynolds number | Definition & History | Britannica (2025). Available at:
<https://www.britannica.com/science/Reynolds-number> (Accessed: 27 November 2025).

Seawater - Properties ([no date]). Available at: https://www.engineeringtoolbox.com/sea-water-properties-d_840.html (Accessed: 27 November 2025).

Serra, P.B. (2019) 'Hydrofoil Design and Construction'.

Simonet, T., Ducoin, A., Rakotomalala, Q., Riou, M. and Yvin, C. (2024) 'Experimental study on dynamic stall of rigid and flexible hydrofoils in towing tank'. *Ocean Engineering* 314, p. 119621. Available at: doi:10.1016/j.oceaneng.2024.119621.

SST k-omega model -- CFD-Wiki, the free CFD reference ([no date]). Available at: https://cfd-online.com/Wiki/SST_k-omega_model (Accessed: 30 November 2025).

Team, R. (2024) 'Unlocking the Secrets of Hydrofoil Physics: 12 Fascinating Insights for 2024! 🌊'. *Hydrofoiling* 18 October. Available at: <https://www.hydrofoiling.org/hydrofoil-physics/> (Accessed: 29 November 2025).

Team, R. (2025) 'How to Choose the Perfect Hydrofoil Size & Setup in 2025 🚀'. *Hydrofoiling* 8 August. Available at: <https://www.hydrofoiling.org/how-do-i-determine-the-optimal-foil-size-and-configuration-for-my-hydrofoil-board/> (Accessed: 29 November 2025).

'The Boundary Layer and Wing Design: Aerodynamics - Aviation Gurukul, GOLN'. (2018) 21 August. Available at: <https://aviationgoln.com/the-boundary-layer-and-wing-design/> (Accessed: 29 November 2025).

Tutorial construction of wings or foils initiation ([no date]). Available at: <https://www.heliciel.com/en/aerodynamique-hydrodynamique/Didacticiel%20construire%20aile%20ou%20foil.htm> (Accessed: 29 November 2025).

What Is Reynolds Number and Why Is It Important? ([no date]). Available at: <https://resources.system-analysis.cadence.com/blog/msa2022-what-is-reynolds-number-and-why-is-it-important> (Accessed: 28 November 2025).

'What is Reynolds Number for Turbulent Flow - Definition'. (2019) *Thermal Engineering* 22 May. Available at: <https://www.thermal-engineering.org/what-is-reynolds-number-for-turbulent-flow-definition/> (Accessed: 28 November 2025).

'What Is the Reynolds Number and Why Is It Important?'. (2025a) *Engineer Fix* 4 October. Available at: <https://engineerfix.com/what-is-the-reynolds-number-and-why-is-it-important/> (Accessed: 27 November 2025).

'What Is the Reynolds Number and Why Is It Important?'. (2025b) *Engineer Fix* 4 October. Available at: <https://engineerfix.com/what-is-the-reynolds-number-and-why-is-it-important/> (Accessed: 28 November 2025).

'Wing Foil Buyers Guide: Boards, Foils & Wing Sizes'. (2025) 1 October. Available at: <https://www.kingofwatersports.com/blog/wing-foil-buyers-guide> (Accessed: 29 November 2025).

Yilmaz, İ.H. and Mwesigye, A. (2018) 'Modeling, simulation and performance analysis of parabolic trough solar collectors: A comprehensive review'. *Applied Energy* 225, pp. 135–174. Available at: doi:10.1016/j.apenergy.2018.05.014.

Zarruk, G.A., Brandner, P.A., Pearce, B.W. and Phillips, A.W. (2014) 'Experimental study of the steady fluid–structure interaction of flexible hydrofoils'. *Journal of Fluids and Structures* 51, pp. 326–343. Available at: doi:10.1016/j.jfluidstructs.2014.09.009.

Zhang, J., Chang, Z., Deng, C., Feng, Z., Chu, Y. and Wang, H. (2024) 'Dynamic analysis of flexible hydrofoils on the propulsive performance of wave-powered boats'. *Ocean Engineering* 300, p. 117384. Available at: doi:10.1016/j.oceaneng.2024.117384.