Fluid Mechanics

Contributors of Fluid Mechanics
• Archimedes of Syracuse was an Ancient Greek mathematician, physicist, engineer, inventor, and astronomer. Although few details of his life are known, he is regarded as one of the leading scientists in classical antiquity.
• Established elementary principles of buoyancy and flotation.
JULIUS FRONTINUS, A.D. 40–103

• One of the most distinguished Roman senators of the late 1st century AD.
• He is best known to the post-classical world as an author of technical treatises, especially De aquaeductu, dealing with the aqueducts of Rome.
• Italian polymath whose areas of interest included invention, painting, sculpting, architecture, science, music, mathematics, engineering, literature, anatomy, geology, astronomy, botany, writing, history, and cartography.

• Expressed elementary principle of continuity; observed and sketched many basic flow phenomena; suggested designs for hydraulic machinery.
GALILEO GALILEI, 1564–1642

• Italian astronomer, physicist, engineer, philosopher, and mathematician who played a major role in the scientific revolution of the seventeenth century.

• He has been called the "father of observational astronomy", the "father of modern physics", the "father of scientific method", and the "father of science".

• Stimulated experimental hydraulics; revised Aristotelian concept of vacuum.
• Italian physicist and mathematician, best known for his invention of the barometer and relating barometric height to weight of atmosphere.
• French mathematician, physicist, inventor, writer and philosopher.

• Pascal's earliest work was in the natural and applied sciences where he made important contributions to the study of fluids, and clarified the concepts of pressure and vacuum by generalizing the work of Evangelista Torricelli.

• Clarifying principles of barometer, hydraulic press, and pressure transmissibility.
ISAAC NEWTON, 1642–1727

- English physicist and mathematician who is widely recognized as one of the most influential scientists of all time and a key figure in the scientific revolution
- Explored various aspects of fluid resistance—inertial, viscous, and wave; discovered jet contraction.
- He formulated an empirical law of cooling, studied the speed of sound, and introduced the notion of a Newtonian fluid.
HENRI de PITOT, 1695–1771

• Constructed double-tube device to indicate water velocity through differential head.
• In a pitot tube, the height of the fluid column is proportional to the square of the velocity of the fluid at the depth of the inlet to the pitot tube. This relationship was discovered by Henri Pitot, a French engineer, in 1732, when he was assigned the task of measuring the flow in the river Seine.
Swiss mathematician and physicist who is particularly remembered for his applications of mathematics to mechanics, especially fluid mechanics.

Experimented and wrote on many phases of fluid motion, “hydrodynamics”; devised manometry technique and adapted primitive energy principle to explain velocity-head indication; proposed jet propulsion.
• Swiss mathematician, physicist, astronomer, logician and engineer who made important and influential discoveries in many branches of mathematics and modern mathematical terminology such as the notion of a mathematical function.

• First explained role of pressure in fluid flow; formulated basic equations of motion and so called Bernoulli theorem; introduced concept of cavitation and principle of centrifugal machinery.
• French mathematician, mechanician, physicist, philosopher, and music theorist.
• Originated notion of velocity and acceleration components, differential expression of continuity, and paradox of zero resistance to steady nonuniform motion.
ANTOINE CHEZY, 1718–1798

• French hydraulics engineer. He is known for the Chézy formula, which concerned the velocity of pipe flow, and in modified form he used it for open channel flow as well.

• Formulated similarity parameter for predicting flow characteristics of one channel from measurements on another.
• Italian physicist, savant, man of letters, diplomat and historian of science. He was the discoverer of Venturi effect.

• Performed tests on various forms of mouthpieces in particular, conical contractions and expansions.
• French engineer and physicist who extended equations of motion, formulated the general theory of elasticity, determined the zero line of mechanical stress, established the elastic modulus as a property of materials independent of the second moment of area.
• Navier is therefore often considered to be the founder of modern structural analysis.
• His major contribution however remains the Navier–Stokes equations (1822), central to fluid mechanics.
French mathematician reputed as a pioneer of analysis.

Contributed to the general field of theoretical hydrodynamics and to the study of wave motion.
• German civil engineer who made important contributions to fluid dynamics, hydraulic engineering and probability theory.
• Conducted original studies of resistance in and transition between laminar and turbulent flow.
• French physicist and physiologist who performed precise tests on resistance of flow through capillary tubes.

• Formulated and published, Poiseuille's law (now commonly known as the Hagen-Poiseuille equation), which applies to laminar flow that is, non-turbulent flow of liquids through pipes of uniform section, such as blood flow in capillaries and veins.
• French hydraulic engineer who performed extensive tests on filtration and pipe resistance and first derived the equation (now known as Darcy’s law) that governs the laminar (non-turbulent) flow of fluids in homogeneous, porous media and who thereby established the theoretical foundation of groundwater hydrology.

\[ q = -K \frac{\text{change of head}}{\text{distance}} \]
JULIUS WEISBACH, 1806–1871

• German mathematician who wrote on mechanics, hydraulics and surveying as well as mathematics.
• He refined the Darcy equation into the still widely used Darcy–Weisbach equation.

\[ H_f = \frac{f l \cdot v^2}{d 2g} \]
WILLIAM FROUDE, 1810–1879

- Developed many towing-tank techniques, in particular the conversion of wave and boundary layer resistance from model to prototype scale.
- English engineer and naval architect who influenced ship design by developing a method of studying scale models propelled through water and applying the information thus obtained to full-size ships.
• Irish engineer who proposed several formulas for open-channel resistance.
Irish physicist and mathematician who derived analytically various flow relationships ranging from wave mechanics to viscous resistance—particularly that for the settling of spheres. In physics, Stokes made seminal contributions to fluid dynamics (including the Navier–Stokes equations) and to physical optics. In mathematics he formulated the first version of what is now known as Stokes' theorem and contributed to the theory of asymptotic expansions.
• Austrian physicist and philosopher, noted for his contributions to physics such as study of shock waves. Quotient of one's speed to that of sound is named the Mach number in his honor.
• A prominent innovator from England in the understanding of fluid dynamics
• Described original experiments in many fields: cavitation, river model similarity, pipe resistance and devised two parameters for viscous flow; adapted equations of motion of a viscous fluid to mean conditions of turbulent flow.
• English physicist who earned the Nobel Prize for Physics in 1904.
• He predicted the existence of the surface waves now known as Rayleigh waves.
• Investigated hydrodynamics of bubble collapse, wave motion, jet instability, laminar flow analogies, and dynamic similarity.
VINCENZ STROUHAL, 1850–1922

- Czech physicist specializing in experimental physics.
- He investigated the phenomenon of “singing wires.”
- In dimensional analysis, the Strouhal number (St) is a dimensionless number describing oscillating flow mechanisms.
Stimulated interest in the United States in the use of dimensional analysis.

\[ X = C X_1^a X_2^b X_3^c \ldots X_n^m \]

where \( C \) = dimensionless constant

\( a, b, c, \ldots, m \) are arbitrary exponents.

\( X_1, X_2, \ldots, X_n \) = independent variables
• Emphasized the use of the principles of similitude in fluid flow studies and formulated a capillarity similarity parameter.

• The Weber number (We) is a dimensionless number in fluid mechanics that is often useful in analyzing fluid flows where there is an interface between two different fluids, especially for multiphase flows with strongly curved surfaces.

Splash
LUDWIG PRANDTL, 1875–1953

• Introduced concept of the boundary layer and is generally considered to be the father of present-day fluid mechanics.

• Developed the mathematical basis for the fundamental principles of subsonic aerodynamics in particular; and in general up to and including transonic velocities.
• Provided many innovations in the field of hydraulic machinery. Proposed a method of correlating pipe resistance data that is widely used.
One of the recognized leaders of twentieth century fluid mechanics. Provided major contributions to our understanding of surface resistance, turbulence, and wake phenomena.
• One of the first students of Prandtl who provided a mathematical basis for boundary-layer drag but also showed as early as 1911 that the resistance to flow through smooth pipes could be expressed in terms of the Reynolds number for both laminar and turbulent flow.
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