Series Editor
Roger Prud'homme

Dimensional Analysis and Similarity in Fluid Mechanics

Nord-Eddine Sad Chemloul

Color Section

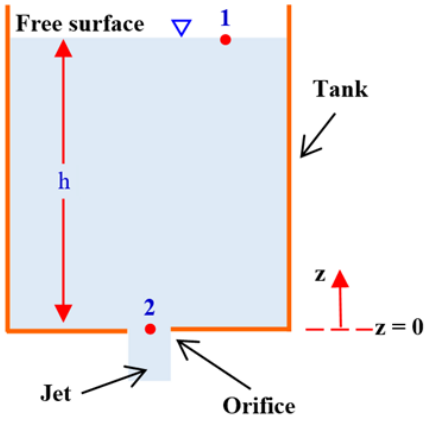


Figure 1.1. *Flow through an orifice, establishing of the Torricelli relationship; HRP: horizontal reference plane*

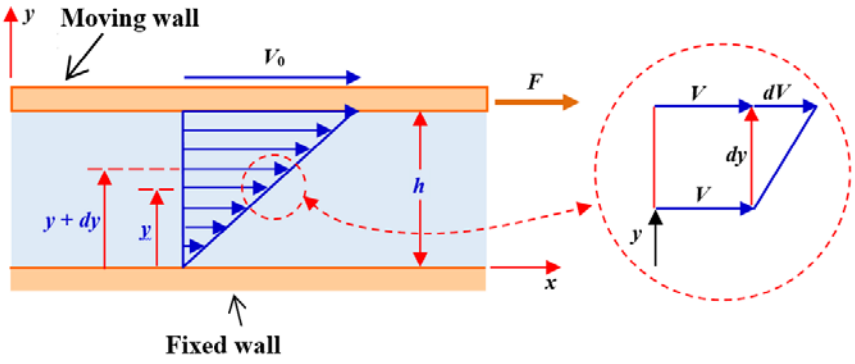


Figure 1.2. *Newton's experiment known as the "moving wall"*

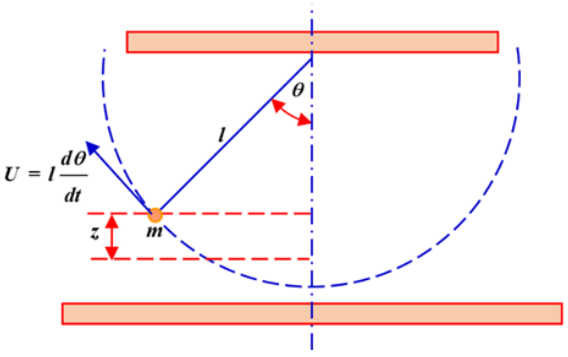


Figure 2.1. *Pendulum in oscillation: $z = l(1 - \cos\theta)$.*

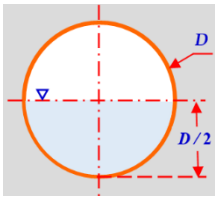
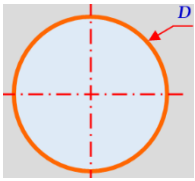
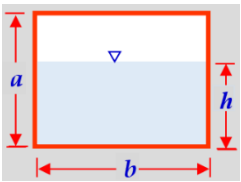
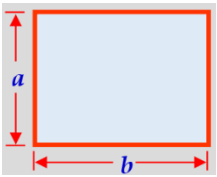
	Free surface flow	Load flows
Shape of cross section		
Cross-section area	$S_m = \frac{1}{2}\frac{\pi D^2}{4}$	$S_m = \frac{\pi D^2}{4}$
Wetted perimeter	$Pe_m = \frac{\pi D}{2}$	$Pe_m = \pi D$
Hydraulic diameter	$D_H = \frac{4S_m}{Pe_m} = D$	$D_H = \frac{4S_m}{Pe_m} = D$
Shape of cross section		
Cross-section area	$S_m = bh$	$S_m = ab$
Wetted perimeter	$Pe_m = b + 2h$	$Pe_m = 2(b + a)$
Hydraulic diameter	$D_H = \frac{4bh}{b + 2h}$	$D_H = \frac{4bh}{2(a + b)}$

Table 2.1. *Some expressions of hydraulic cross-section diameter using simple geometry*

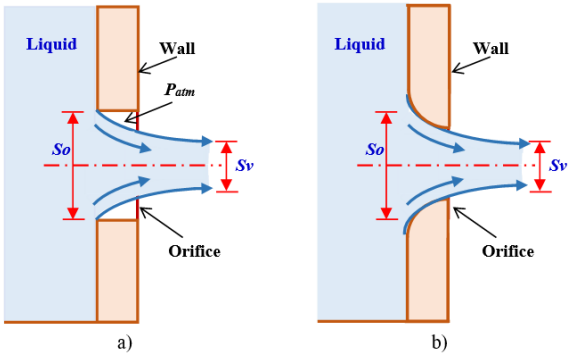


Figure 2.4. *Flow through orifices: (a) a thin-walled orifice; (b) a round-edged orifice*

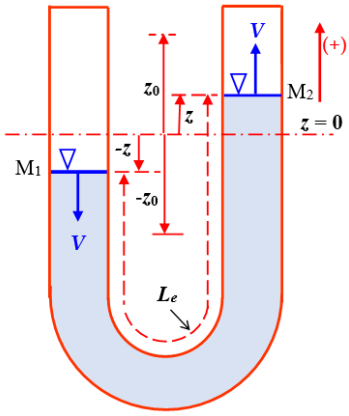


Figure 2.6. *Oscillation of a liquid in a U-shaped tube*

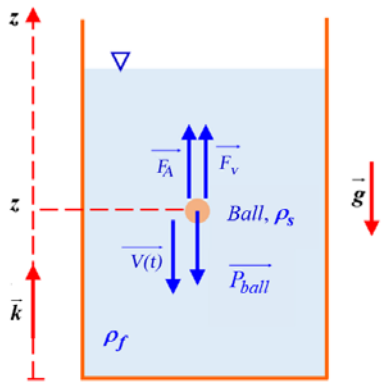


Figure 2.7. *Falling ball viscometer*

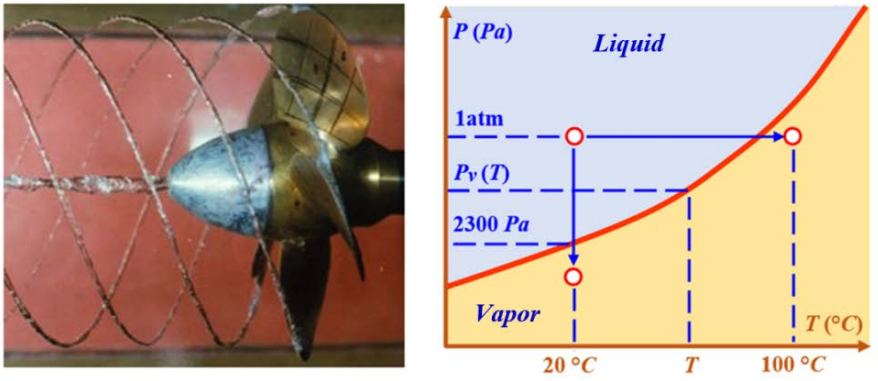


Figure 2.8. *The phenomenon of cavitation and its thermodynamic diagram: a) an example of cavitation occurring on a propeller; b) thermodynamic diagram*

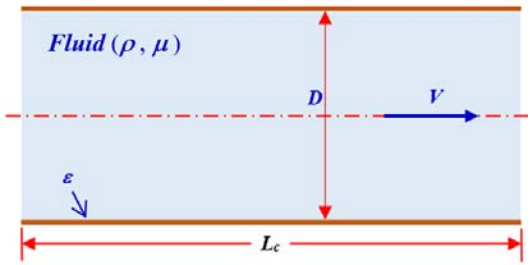


Figure 2.9. *Pressure drop in horizontal pipe of circular cross-section*

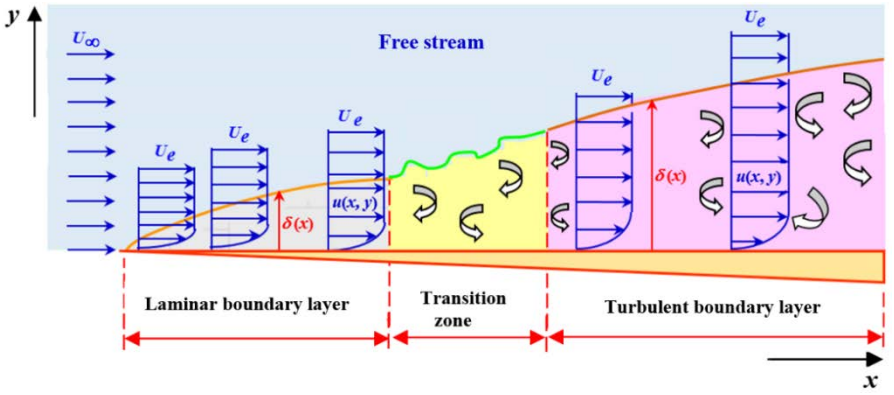


Figure 2.10. *Flow near a flat wall (dynamic boundary layers)*

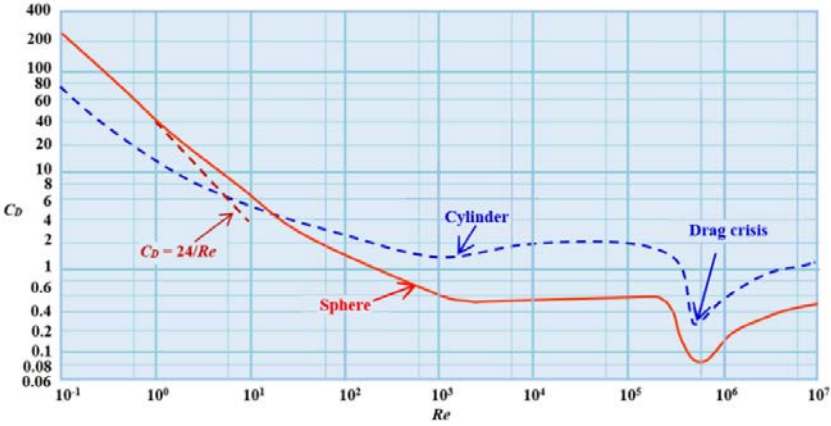


Figure 2.11. *Variation of the drag coefficient as a function of the Reynolds number in the case of a sphere and a cylinder*

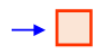
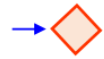
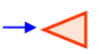
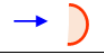
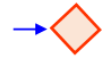
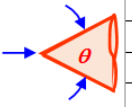
	Shape	C_D		Shape	C_D
Two dimensional	Square			Half tube	
		2.1			1.2
		1.6			2.3
	Half cylinder			Equilateral triangle	
		1.2			1.6
		1.7			2.0
Three dimensional	Cub			Spherical cap	
		1.07			0.4
		0.81			1.4
	Cone	θ (°)	C_D	Parachute	
		10	0.30		1.2
		20	0.40		
		30	0.55		
		40	0.65		
		60	0.80		
		90	1.15		

Table 2.5. *Drag coefficient values for two-dimensional and three-dimensional objects calculated on the front surface area for a Reynolds number greater than or equal to 10^5*

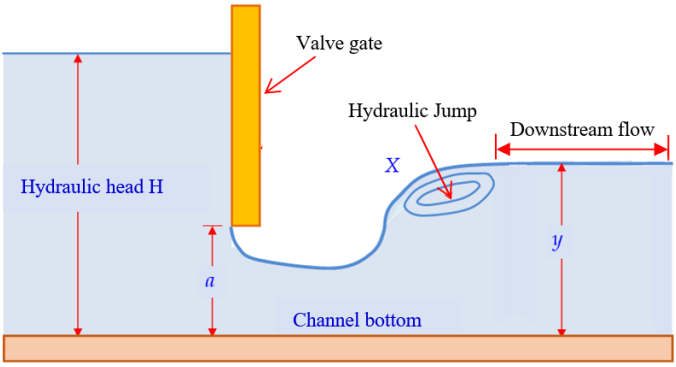


Figure 2.12. *Flow in a channel*

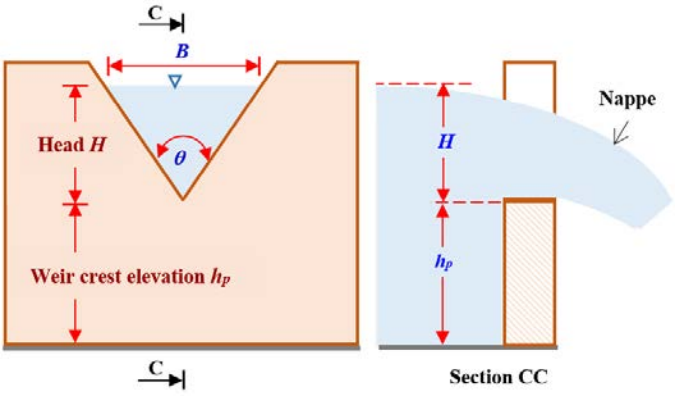


Figure 2.13. *Dimensions of a triangular spillway*

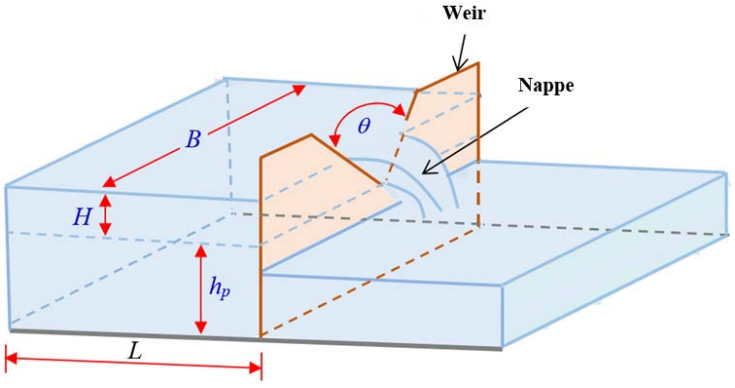


Figure 2.14. *Triangular notch weir with thin wall, placed in a hydraulic channel*

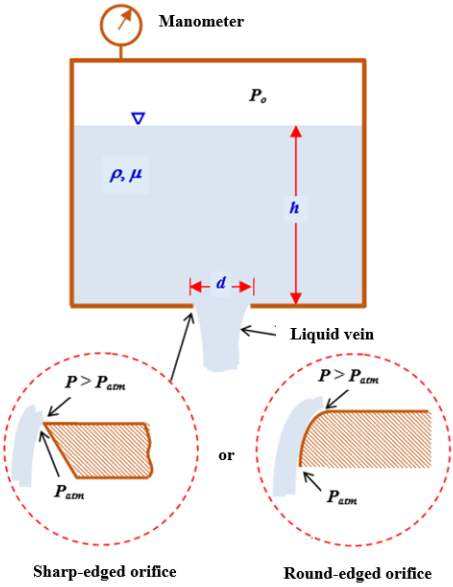


Figure 2.15. *Determining the volumetric flow through an opening; P_{atm} designating atmospheric pressure*

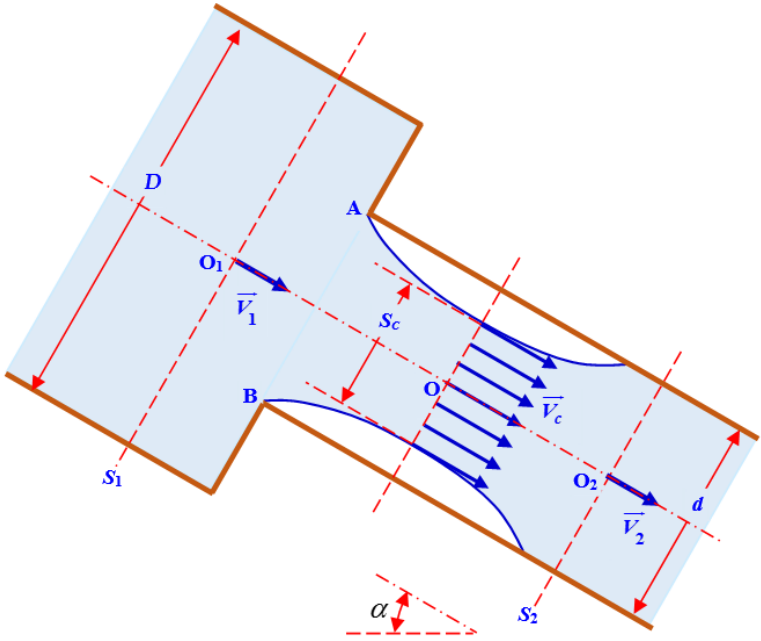


Figure 2.16. *Flow in a sharply narrowing section*

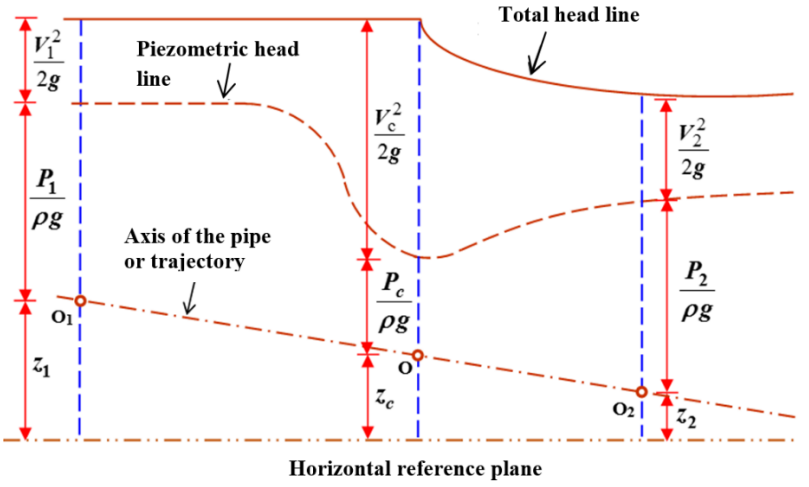


Figure 2.17. *Progression of the load line and the piezometric line through a sharply narrowing segment*

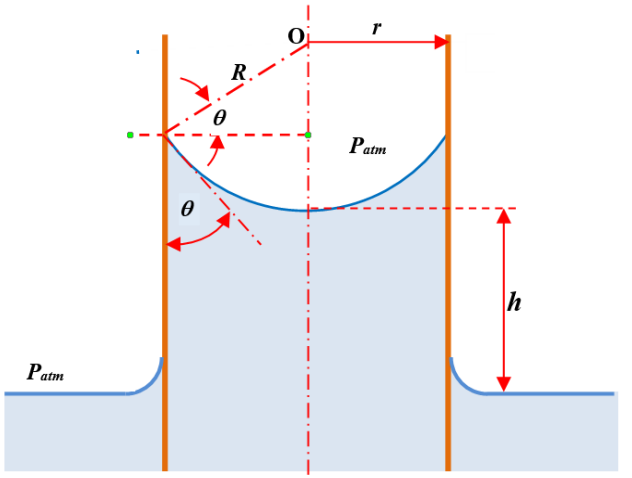


Figure 2.18. *Capillary rise in the case of water that dampens the solid from which the capillary tube is created*

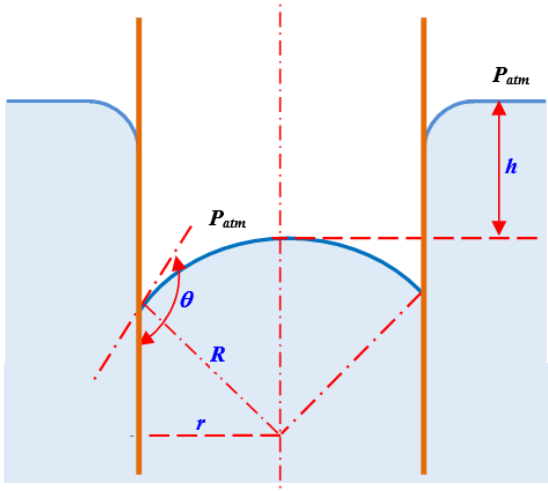


Figure 2.19. *Capillary depression in the case of mercury that does not dampen the solid from which the capillary tube is made*

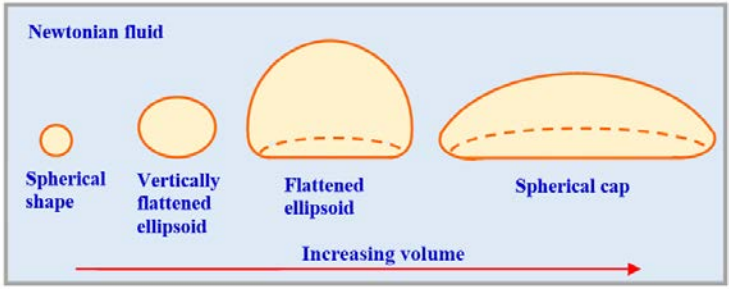


Figure 2.20. *Generic form of bubbles in a Newtonian fluid*

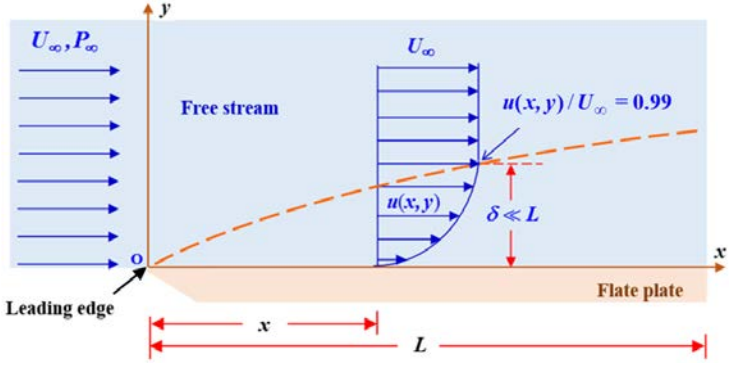


Figure 2.21. *Laminar dynamic boundary layer on a flat wall*

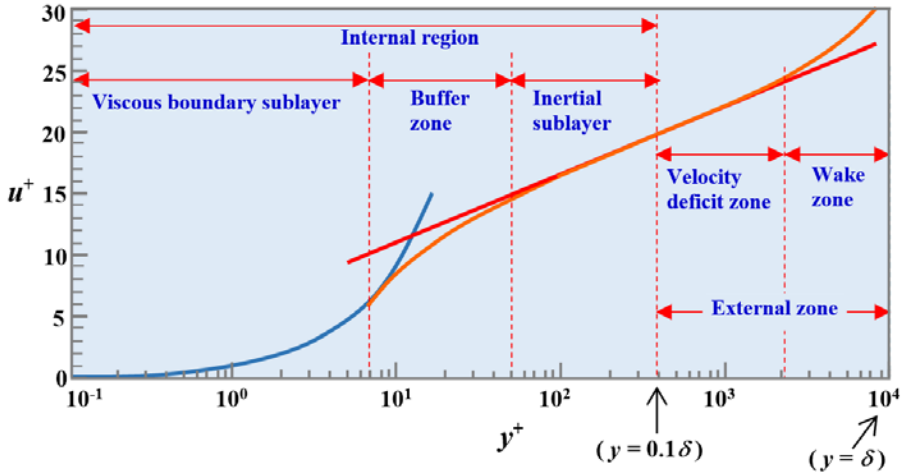


Figure 2.22. *Velocity profile through the turbulent boundary layer of a flat plate*

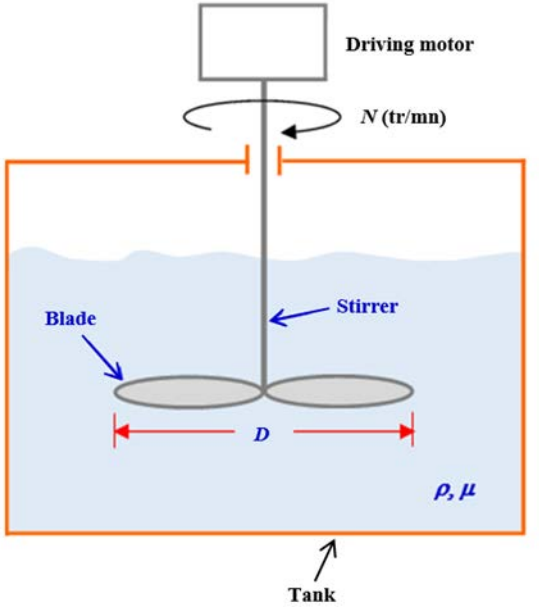


Figure 2.23. *Scheme of a stirrer for liquids*

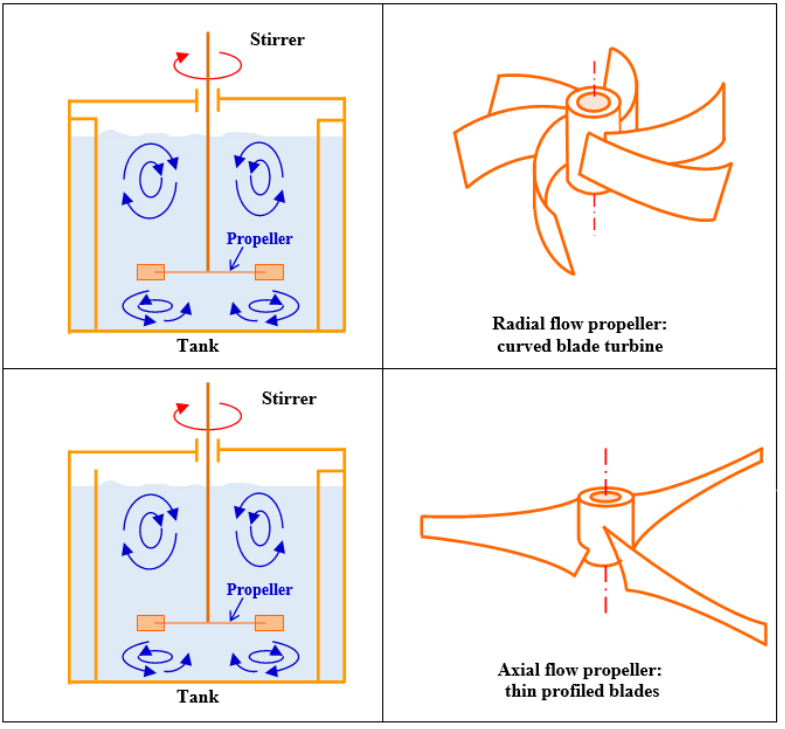


Figure 2.24. *Example of axial and radial flow propellers*

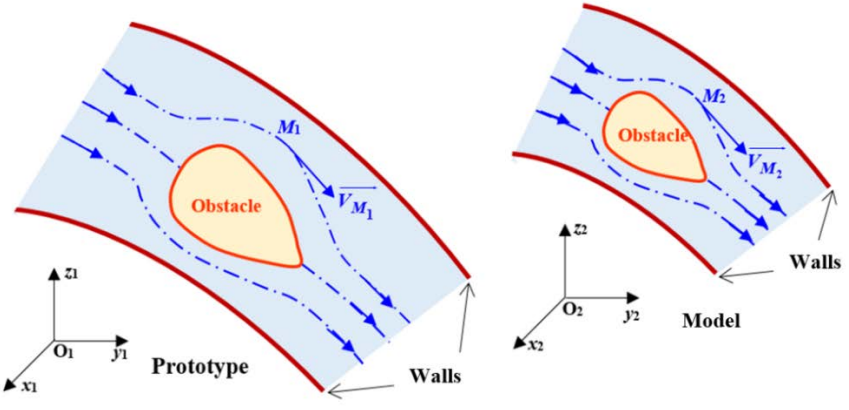


Figure 3.1. *Similarity of two flows*

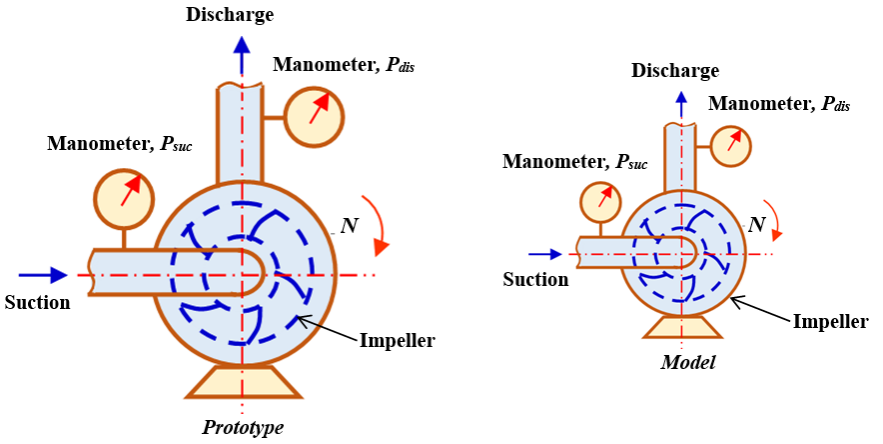


Figure 3.2. *Model and prototype of a centrifugal pump*

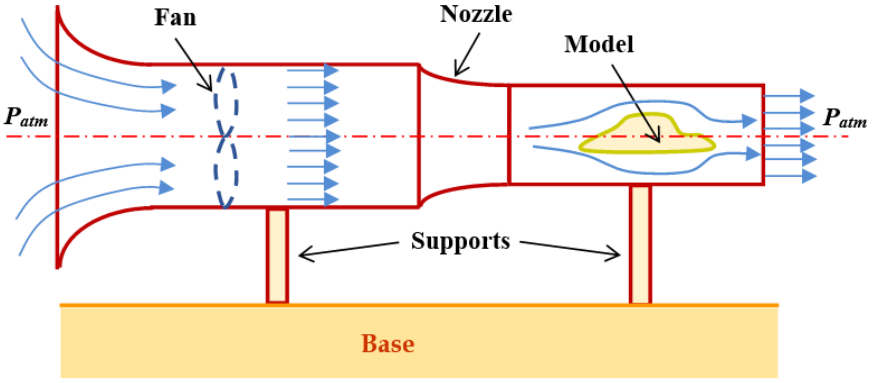


Figure 3.3. *Diagram of a wind tunnel*

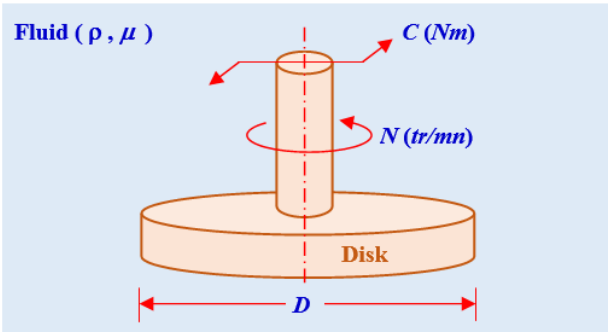


Figure 3.4. *Disk rotating in a viscous fluid*

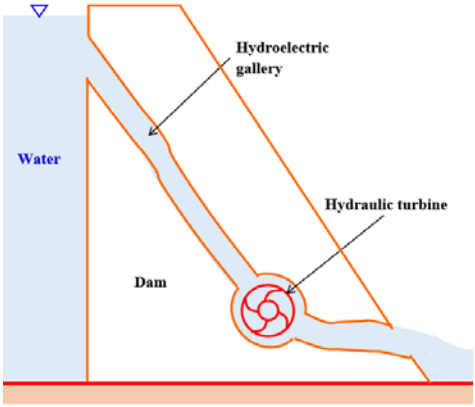


Figure 3.5. *Hydroelectric development gallery*

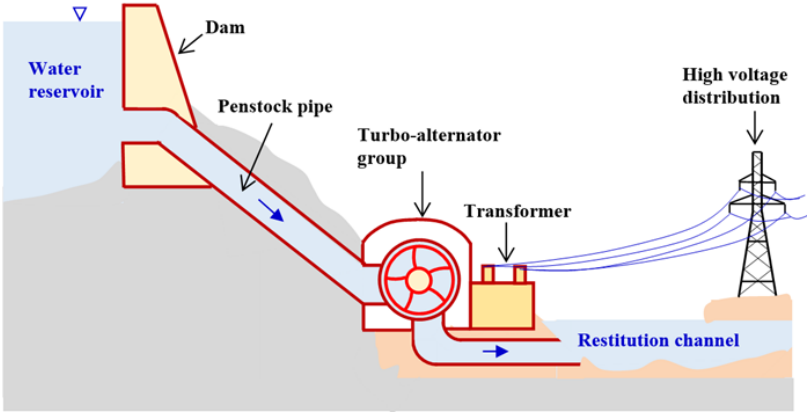


Figure 3.6. *Principle of operation of a gravity-powered hydroelectric power plant*

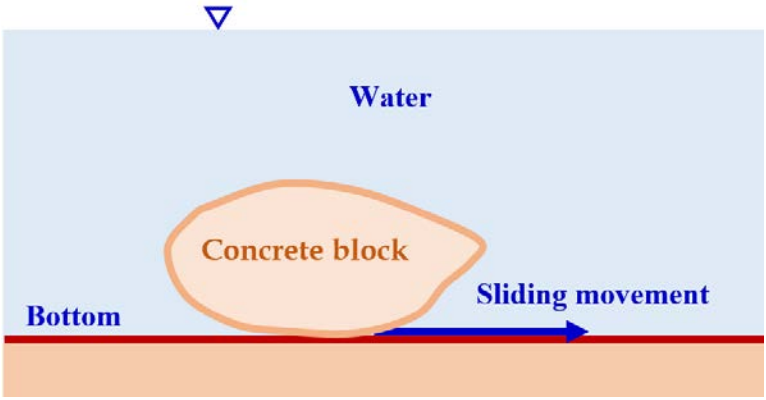


Figure 3.7. *Sliding a concrete block along the bottom of a river*

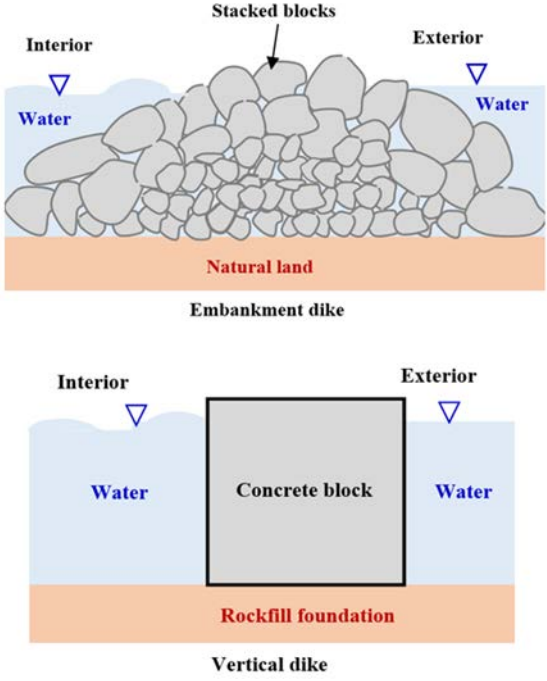


Figure 3.8. *The two main types of levees*

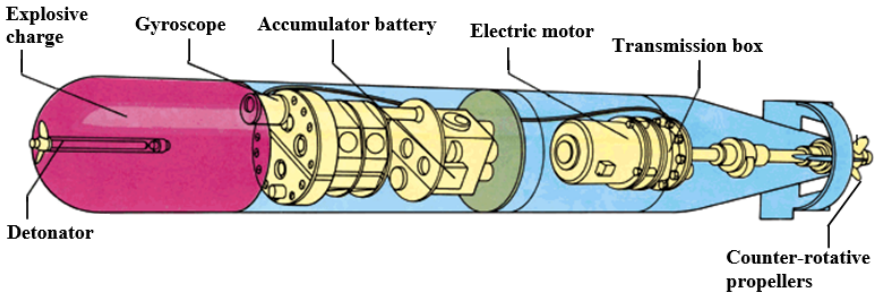


Figure 3.13. *Example of a torpedo*

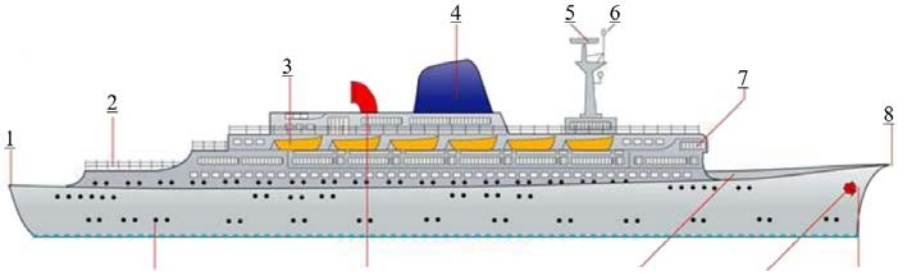


Figure 3.15. *Example of a ship designed for carrying passengers: 1) pump; 2) deck; 3) lifeboat; 4) chimney; 5) radar; 6) masthead light; 7) bridge; 8) bow; 9) anchor; 10) study; 11) bulwark; 12) windsock; 13) porthole*

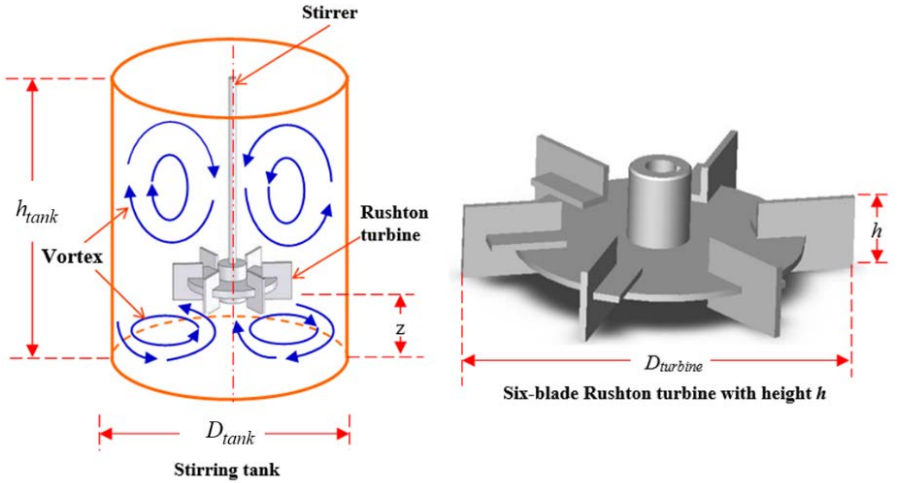


Figure 3.16. *Stirring tank with six-blade Rushton turbine*[19]