1
Introduction

PART A—GENERAL

1.1 Fluid Properties

Table 1. Mass density, ρ, specific weight, γ, kinematic viscosity, ν, of some common fluids at 20°C and atmospheric pressure.

Fluid	*Mass Density*		*Specific Weight, γ*		*Kinematic Viscosity ν*
	S.I. Unit kg/m³	*M.K.S. Unit msl/m³*	*S .I. Unit kgf/mm²*	*M.K.S. Unit kgf / m³*	*S.I. and M.K.S. Units m²/s*
Water	1000	101.8	9810.0	1000	1.0×10^{-6}
Air	1.236	0.126	11.85	1.208	1.5×10^{-6}
Alcohol	789	80.4	7738.0	789	1.5×10^{-5}
Glycerine	1268	129.23	12356.0	1260	6.3×10^{-4}
Mercury	13533	1380.0	132880.0	13550	1.16×10^{-7}
Carbon Tetra Chloride	1594	162.5	15632.0	1594	6.04×10^{-7}

Table 2. Mass Density of Air, kinematic vicosity of air and water at different temperatures.

Temperature °C	Mass Density of Air		*Kinematic Viscosity of*	
1	*M.K.S. Unit msl/m³* (2)	*S.I. Unit kg/m³* (3)	Air ($\nu \times 10^{-6}$) m^2/s (4)	*Water* ($\nu \times 10^{-7}$) m^2/s *5*
12	0.1265	1.241	14.34	12.48
13	0.1261	1.237	14.45	12.10
14	0.1258	1.234	14.54	11.78
15	0.1250	1.226	14.64	11.44
16	0.1245	1.221	14.74	11.17
17	0.1241	1.217	14.84	10.89
18	0.1238	1.214	14.93	10.60
19	0.1234	1.211	15.02	10.30
20	0.1230	1.207	15.11	10.05
21	0.1225	1.202	15.21	9.80
22	0.1220	1.197	15.30	9.58

23	0.1217	1.194	15.39	9.37
24	0.1212	1.189	15.48	9.17
25	0.1209	1.186	15.58	8.96
26	0.1206	1.183	15.66	8.77
27	0.1200	1.177	15.75	8.58
28	0.1195	1.172	15.84	8.40
29	0.1193	1.170	15.94	8.23
30	0.1188	1.165	16.03	8.05

Table 3. Physical quantities and their units

Physical Quantity	*Dimension*	*M.K.S. Unit*	*S.I. Unit*
Length	L	Metre (m)	Metre (m)
Mass	M	Metric slug (msl)	Kilogram (kg)
Time	T	Second (s)	Second (s)
Force	MLT^{-2}	Kilogram (kgf)	Newton (N)
Energy	$ML^2 T^{-2}$	Kilogram-Metre (kgf-m)	Joule (J)
Power	$ML^2 T^{-3}$	Kilogram-Metre/second (kgf-m/s)	Watt (W)
Dynamic Visocosity	$ML^{-1} T^{-1}$	Kilogram-Second/ {(Metre)^2 kgf–s/m^2	Newton-Second/(Metre)^2 (Ns/m^2)

1.2. Definitions

1.2.1. Fluid Mechanics. It may be defined as mechanics of fluids including water. It is a physical science concerned with the behaviour of fluids at rest and in motion.

1.2.2. Hydraulics. The word hydraulics has been defined from a Greek word 'Hudour', which means water. The subject of hydraulics can be defined as that branch of engineering science, which deals with water at rest or in motion.

1.2.3. Fluid. Any substance which deforms continuously under the action of shear stress regardless of its magnitude is termed as fluid. Fluids can exist in solid, liquid or gaseous states. On the removal of shear force the fluid attains its new shape and position.

1.2.4. Specific Gravity. Also referred to as relative density. It is the ratio of unit weight or mass density of the fluid to that of pure water at a standard temperature and pressure, *i.e.* at 20°C and 101.325 kN/m^2. Being a pure number, the relative density is independent of the system of units used. It is generally denoted by symbol S.

1.2.5. Specific Volume. v is the volume of the fluid per unit weight.

1.2.6. Specific Weight, denoted by γ (Gama). It is the weight of the fluid per unit volume, *i.e.* $\gamma = \frac{1}{v}$. It is also termed as weight density or unit weight.

1.2.7. Mass Density. The mass density of a fluid designated by a symbol ρ (Rho), is the mass of fluid per unit volume, *i.e.* $\rho g = \gamma$ or $\rho = \frac{\gamma}{g}$.

1.2.8. Viscosity. It is the property of a fluid by virtue of which it offers resistance to deformation under the influence of a shear force. It is a friction force which opposes the sliding of one particle past another. By viscosity we infer to dynamic viscosity and is represented by the symbol μ (mu). The units being Ns/m^2 or kg/ms. the dynamic viscosity can also be expressed in the units of poise; one poise being equal to 0.10 Ns/m^2 [0.102 kg(f)–sec/m^2]. Water has a viscosity of 1 centipoise, *i.e.* 1/100 of a poise at 20°C and viscosity of any liquid in centipoise at 20°C is an indication of the viscosity of that fluid relative to water. For gases, viscosity increases with increase in temperature while for liquids it is *vice-versa*.

1.2.9. Kinematic Viscosity. It is the ratio of dynamic viscosity and mass density of a fluid; denoted by symbol ν (nu), *i.e.* $\nu = \mu/\rho$. Its units being m^2/s or stoke (cm^2/s).

1.2.10. Ideal Fluids. It is a hypothetical fluid wherein it is taken that the viscosity is zero. An ideal fluid is non-viscous and incompressible.

1.2.11. Real Fluid. All fluids which have viscosity are called real fluids.

1.2.12. Pressure. It is the force exerted upon a unit area. It be assumed that a cross sectional area A is filled upto a height h by a liquid having unit weight γ. The force exerted by the liquid column per unit area at its bottom is equal to,

$$p = \frac{\gamma A h}{A} = \gamma h$$

In fluid mechanics the pressure is generally expressed in terms of height of liquid column, *i.e.* $h = p/\gamma$ where h is known as the pressure head and has the dimension of length.

Steady pressure can be measured using pressure gauges, pressure transducers, piezometers & manometers.

1.2.13. Newtonian and Non Newtonian Fluids. Fluids which obey the Newton's law of viscosity *viz*, $\tau = \mu\, du/dy$ *are called Newtonian fluids and those which do not obey the said law are called Non-Newtonian fluids.*

1.2.14. Discharge. It is the volumetric rate of flow of fluid. It is denoted by Q (m^3/s).

1.2.15. Velocity. By velocity unless specified otherwise, mean velocity of flow is implied and is obtained by dividing the rate of flow Q by the flow cross section, *i.e.*

$$V = \frac{Q}{A}.$$

Velocity at any point in a flow section is commonly measured by means of a Pitot-Static tube or a current meter.

1.2.16. Absolute and Gauge Pressures

Gauge pressure = Absolute pressure – Local atmospheric pressure

and in case the gauge pressure is negative, then

Vacuum or negative pressure = Local atmospheric pressure – Absolute pressure.

The standard atmospheric pressure is taken as equal to 76 cm of mercury.

PART B - INTRODUCTORY THEORY ON FLOW THROUGH OPEN CHANNELS

What is 'Open Channel Flow'. Open channel flow is also known as free surface flow. Open channel flow may be defined as flow of a fluid through any passage under the force of gravity, *i.e.* under atmospheric pressure. The flow of water through an open channel is not due to any pressure but due to the slope of the bed of the channel. The free surface may be defined as the interface between the liquid and overlying gaseous fluid. The interface is subjected to a constant pressure throughout its length and breadth.

Types of Channels. Channels can be classified as follows:

(*a*) *Prismatic Channels.* These are artificial channels made by man and have uniform geometric characteristics. Free surface flow hydraulic theories can be applied to these channel. These prismatic channels can be further classified as: (*i*) Exponential channels, *i.e.* the prismatic channels having their cross-sectional area directly proportional to any power of flow depth. Rectangular triangular and parabolic channels fall under this category. (*ii*) Non-exponential channel are prismatic channels other than exponential ones.

(*b*) *Non-prismatic Channels.* Such channels whose cross-sectional area and bed slope are not uniform along their length are known as non-prismatic channels.

Table 1.4. Open Channels Flow and Pipe Flow—A Comparison

Channel Flow (1)	*Pipe Flow* (2)
1. V.T. CHOW defines an open channel as a conduit in which water flows with a free surface.	1. A pipe flow does not have a free surface; it flows full.
2. The flow in open channels is caused by the gravity force due its sloping bottom, *i.e.* pressure at a point at a depth y below the free surface will be γy.	2. The flow through a pipe takes place under hydraulic pressure, *i.e.* pressure decreases in the direction of flow.
3. Piezometric head in open channel flow is $Z + y$.	3. Piezometric head in pipe flow is $Z + \frac{p/r}{p/y - \gamma} P/r$
4. The geometry of the conduit defines fully the cross-section of flow.	4. The determination of flow cross-section is subject to prediction and approximation.
Fig. 1.1 (*a*)	Fig. 1.1 (b)
(*i*) Maximum velocity occurs at a point little below the water surface. (*ii*) If the channel bed is mobile the velocity at the bottom of the channel will not be zero.	(*i*) Velocity distribution is symmetrical about the pipe axis. (*ii*) Maximum velocity occurs at the pipe axis. (*iii*) At the walls there is zero velocity.

Classification of Flow Through Open Channels

Ven Te Chow's classification based on variation with respect to time and space is illustrated diagrammetically as follows:

Another classification of flow exists based on the spread of a minor disturbance in the flow, *i.e.*

(*i*) *Tranquil or sub-critical flow.* A flow is said to be tranquil or sub-critical as to when a minor disturbance can spread upstream from the point of origin.

(*ii*) *Super critical or shooting or rapid flow.* In this flow the disturbance is swept down stream owing to the high velocity of flow.

(*iii*) *Critical flow.* Successive waves being stationary coincide with the point of impact.

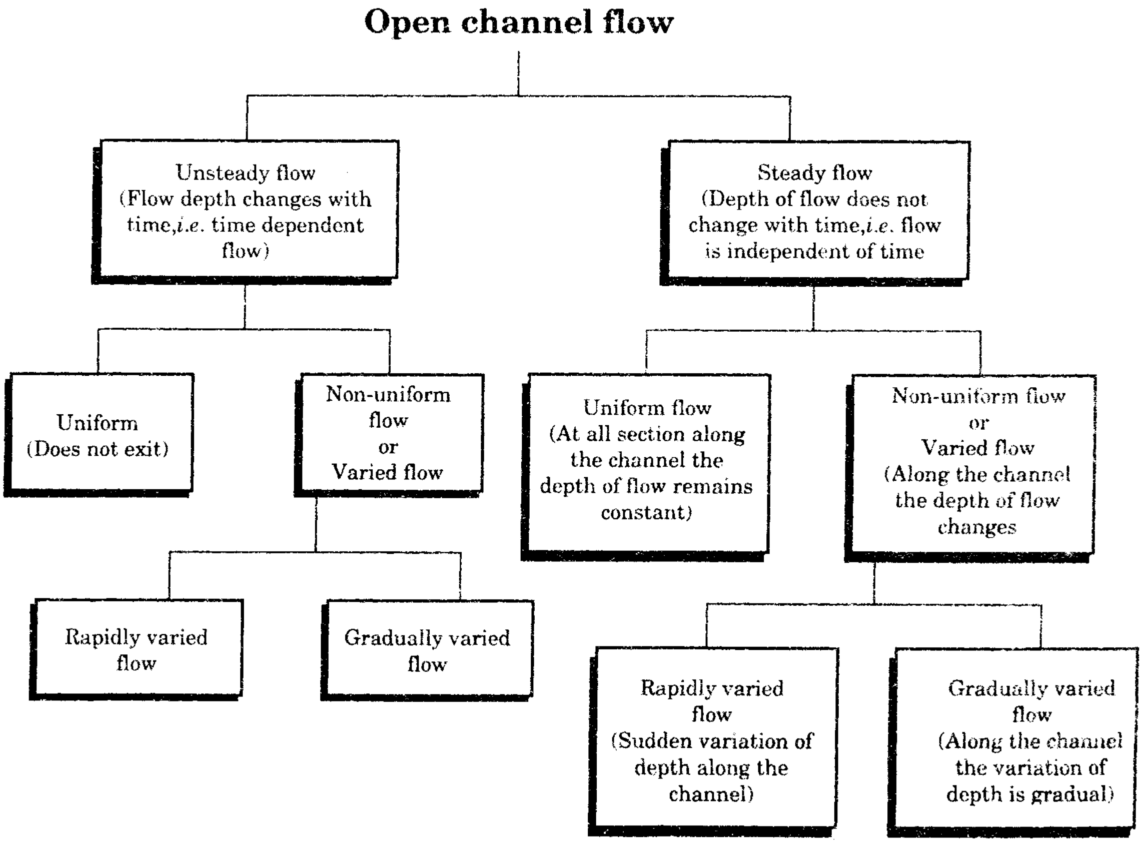


Fig. 1.1 (*c*)

Effect of Froude's Number and Reynold's Number on Open Channel Flows

F (Froude No.) $= \dfrac{V}{\sqrt{gD}}$ where

D (hydraulic mean depth) $= \dfrac{\text{Area of flow}}{\text{Top width at the free surface}}$

(*i*) If $F < 1$ the flow is sub-critical.

(*ii*) If $F = 1$ the flow is critical.

(*iii*) and for $F > 1$ the flow is super critical.

Reynolds No. $\quad R_e = \dfrac{\rho VL}{\mu}$

where L the characteristic length is the hydraulic radius R, where R is the ratio of area of flow A to the wetted perimeter P.

(*i*) If R_e is < 500 the flow is laminar.

(*ii*) If R_e is between 500 to 2000 the flow is transitional.

(*iii*) If R_e is > 2000 the flow is turbulent.

Various Formulae Giving Velocity of Flow Through Open Channels

Noteworthy formulae are as follows:

(*i*) Chezy's formula or equation $V = C\sqrt{RS}$

where $R = A/P$ is the hydraulic redius.

S = channel slope

and C = Chezy's constant.

Value of C Chezy's constant have been given as

(*a*)
$$C = \frac{157.6}{1.81 + \frac{m}{\sqrt{R}}}$$

where m is the co-efficient of roughness, dependent on the bed material.

Table 1.5 Values of m in the Bazin's Formula

S. No.	*Type of bed surface of channel*	*Value of m*
1	Rough earthen surface	3.17
2	Ordinary surface made of earth	2.35
3	Very good surface made of earth	1.54
4	Rubble stone or poor brick work	0.83
5	Unplaned wood, brickwork or stone	0.21
6	Planed wood or smooth cement plaster	0.11

(*b*) **Powell Formula.** For rough boundaries and turbulent flow values of Chezy's constant C was proposed by Powell as

$$C = 42 \log \frac{R_e}{\varepsilon}$$

where ε is the measure of roughness and R_e is the Reynolds Number whereas for smooth channels and high values of Reynolds Number, he proposed

$$C = 42 \log \frac{4R_e}{C}$$

(*c*) **Ganguillet and Kutter's Formula.** Here value of Chezy's constant C has been proposed as

$$C = \frac{23 + \frac{1}{n} + \frac{0.00155}{5}}{1 + \left(23 + \frac{0.001555}{s}\right)\frac{n}{\sqrt{R}}}$$

where n is a measure of bed roughness and is known as Kutter's n and R is the hydraulic radius in metres.

(2) Manning has also proposed the following formula for flow velocity in open channels:

viz.
$$V = \frac{1}{n} R^{2/3} S^{1/2}$$

where V = mean velocity of flow in m/sec.

R = hydraulic radius in metres

n = co-efficient of roughness also known as co-efficient of rugosity or Manning's n.

The following table after V.T. Chow gives the values of n for different types of channels encountered in engineering practice.

Table 1.6. Value of *n* for different channels.

S. No. (1)	*Type of bed surface of channel* (2)	*n* (3)
1	Major streams	0.025 to 0.050
2	Stream through trees with flood stage reaching branches	0.120
3	Stream through tree stumps	0.040
4	Stream through dense willows	0.150
5	Mountain streams with large boulders	0.050
6	Mountain streams with gravels and cobbles	0.040
7	Minor streams with stones and weeds	0.035
8	Minor streams, clean, straight	0.030
9	Channels with dense brush high stage	0.010
10	Channels with dense weeds, high as flow depth	0.080
11	Channels of rack cuts	0.040
12	Channel with cobble bottom and clean sides	0.040
13	Channel with stony bottom and weedy banks	0.035
14	Earthen channels with some weeds	0.030
15	Earthen channels, clean and straight	0.022
16	Rubble masonry, cemented	0.025
17	Brickwork lined with cement mortar	0.015
18	Drainage tiles	0.013
19	Concrete culverts	0.013
20	Glass	0.010
21	Corrugated metal	0.024
22	Coated cast Iron	0.014

Chezy's constant C and Manning's n are correlated as

$$C = \frac{1}{n} R^{1/6}$$

Further it would be worth mentioning that by hydrodynamically rough boundaries Manning's n has been related to the material forming the channel bed as

$$n = \frac{d_{50}^{1/6}}{21}$$

where d_{50} is in metres and represents a size such that 50% of the bed material is finer than d_{50}.

(3) The Pavlovsky Formula is as follws:

$$V = \frac{R^v}{n} \sqrt{RS}$$

where $$y = 2.5 \sqrt{n} - 0.13 - 0.75 \sqrt{R} (\sqrt{n} - 0.10)$$

The formula is valid for values of R from 0.1 to 3.0 m and for n between 0.011 and 0.040 Pavlovsky simplified the calculation of y as follows.

$$y = 1.5 \sqrt{n} \text{ for } R < 1.0 \text{ m}$$

. $$y = 1.3 \sqrt{n} \text{ for } R > 1.0\ m$$

Average Shear Stress. Average shear stress τ_0 is expressed by the following relationship:

$\tau_0 = \gamma RS$, where γ is the specific weight of the fiuid, R the hydraulic radius and S the channel slope.

Most Economical or Hydraulically Efficient Channel Cross-section. A channel which for a given slope, co-efficient of roughness and area of flow carries the maximum discharge or flow rate. It is also defined as a channel which involves least excavation for a design discharge; it is also defined as a channel of minimum wetted perimeter which results in maximum discharge owing to least resistance to flow.

Condition for a rectangular, trapezoidal and circular channels to be hydraulically efficient

(*i*) *Rectangular Channel* : (*a*) width b = 2 times depth y

(*ii*) also $R = y/2$.

(*iii*) *Trapezoidal Channel* : (*a*) $R = y/2$

(*b*) Its sides makes 60° angle with the horizontal.

(*iii*) *Circular Channel :* Maximum discharge takes place as to when the depth of water is ≈0.95 times the diameter of the circular channel, *i.e.* depth of flow $y = 1.898\, r_0$ or 0.949 diameter.

Table 1.7. Velocity Distribution for Rough and Smooth Channels

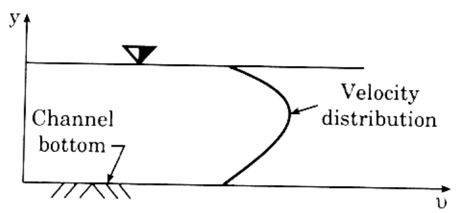
<table>
<tr><th>Rough Channels</th><th>Smooth Channels</th></tr>
<tr><td>1. 

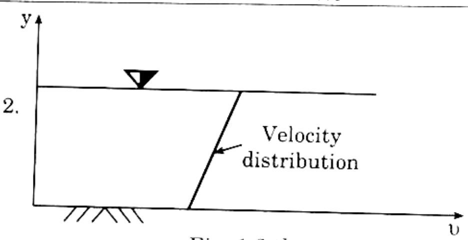
Fig. 1.2 (a)</td><td>2. 

Fig. 1.2 (b)</td></tr>
<tr><td>2. Value or energy co-efficient is = 1.75 and of the momentum co-efficient is = 1.25.</td><td>2. Value of energy co-efficient is = 1.75 and of the momentum co-efficient is = 1.05.</td></tr>
<tr><td>3. Equations of velocity distribution as given by Pradtl Karman and Keulegan respectively are
$u = 5.75\, u_* \log_{10} \frac{30y}{k}$
and $\frac{V}{u_*} = 6.25 + 5.75 \log_{10} \frac{R}{k}$
where u = velocity at a distancy y from the channel bed
$u^* = \sqrt{gRS}$ it is shear velocity
V = mean velocity of flow
R = hydraulic radius
k = height of surface roughness.</td><td>3. Equations of velocity distribution as given by Prandtl Karman and Keulegan respectively are
$u = 5.75\, u_* \log_{10} \frac{9y\, u_*}{\upsilon}$
and $\frac{V}{u^*} = 3.24 + 5.75 \log_{10} \frac{Ru_*}{\upsilon}$
Various terms have the same meaning as on left hand side.</td></tr>
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Discharge through an open channel. The theoretical discharge through an open channel is expressed by the relation

$$Q = A_2 \sqrt{\frac{2g\,(\Delta y - h_f)}{1 - (A_2/A_1)^2}}$$

where h_f is the energy head lost between sections 1 and 2, y is the drop in the water surface between the two sections and A_1 and A_2 the cross-sectional areas of flow at the two sections respectively.

Specific Energy

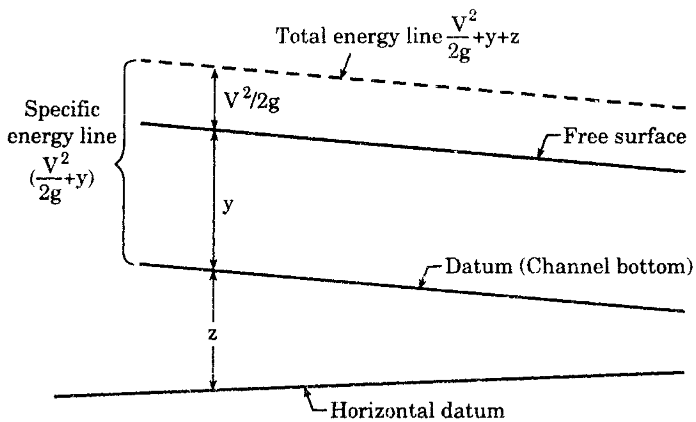

Fig. 1.3

The total energy of flow per unit weight of the fluid is given by

$$z + y + \frac{V^2}{2g}$$

The concept of specific energy was given by Boris A. Bakkmeteff in 1912. Specific energy is sum of the pressure (potential) energy and velocity (kinetic) energy at a point, *i.e.* specific energy E is the energy per unit weight of the flowing fluid measured above the channel bottom

i.e. $$E = y + \frac{V^2}{2g} = y + \frac{Q^2}{2g\,A^2}$$

also $$E = E_\alpha + E_\beta \text{ where } E_\alpha = y \text{ and } E_\beta = \frac{V_2}{2g}$$

i.e. $E = f(y, Q)$ for a given channel.

Critical, Sub-Critical and Super Critical Flows

Consider a rectangular channel of width b. Let depth of flow be y. Area of flow becomes by, and the discharge per unit width Q/b denoted by q . Therefore, specific energy E can be denoted as

$$E = y + \frac{(q.b)^2}{2g\,(b.y)^2} = y + \frac{q^2}{2gy^2} = f(y,q)$$

i.e. a plot between E and y can be prepared for a given discharge using the above equations.

The plot under reference is illustrated as follows :

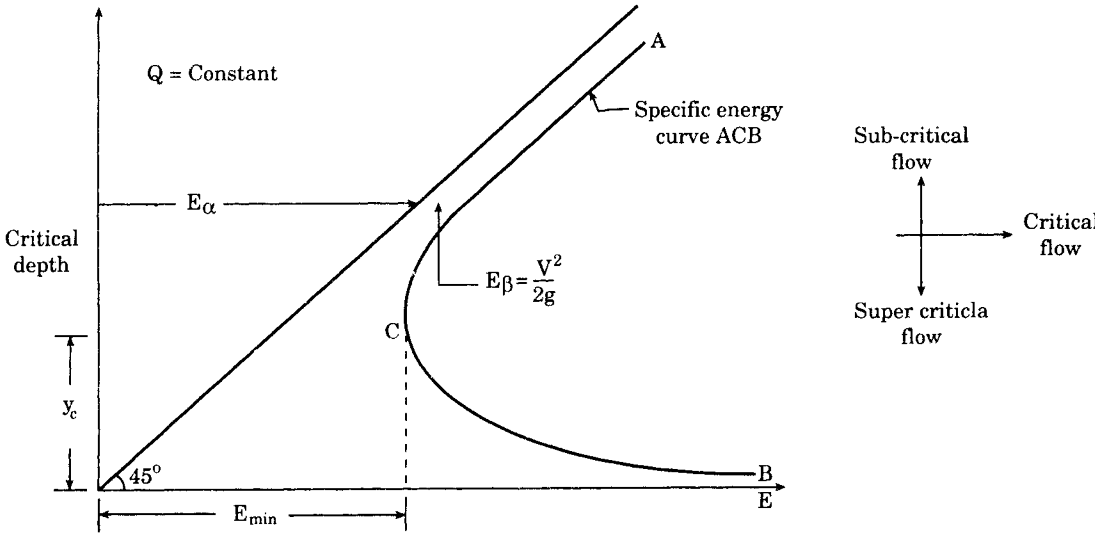

Fig. 1.4 Specific energy curve.

Crictical depth y_c is the depth of flow which corresponds to minimum specific energy. The flow at the critical depth is called critical flow and the velocity of flow is called critical velocity. When (*i*) the velocity of flow is less than the critical velocity, *i.e.* depth is greater than critical depth, the flow is known as tranquil or sub-critical flow (*ii*) the velocity of flow is greater than the critical velocity, *i.e.* depth is less than the critical depth, the flow is known as rapid or super critical.

Value of Froude number $F = \frac{C}{\sqrt{gy}}$

is =1 for critical flow, $F < 1$ for sub-critical flows and $F > 1$ for super critical flows.

PART C - MEASUREMENT OF DISCHARGE

(*a*) **Theory.** Discharge is the volumetric rate of flow of fluid. Discharge Q can be measured by the following three methods:

(*a*) Gravimetric Method
(*b*) Volumetric Method
(*c*) Standard Flow Rate Meter.

(*d*) *Gravimetric Method.* For smaller discharges this method is preferred.

The discharging fluid is collected in a container over a known period of time. Discharge of the fluid is computed as follows:

Weight of bucket $= W_1$ kgf
Weight of bucket + Collected fluid $= W_2$ kgf
Time period of collection $= T$ minutes
Volume of fluid collected $= \frac{W_2 - W_1}{\gamma}$ m^3

where γ is the specific weight of the fluid.

∴ Discharge $$Q = \frac{W_2 - W_1}{\gamma T \times 60} \text{ m}^3/\text{sec} \quad ...(1.1)$$

(*b*) *Volumetric Method.* In a container of known dimensions the discharging fluid is collected. The rise of the fluid level in the tank is measured from the piezometer tube fitted by the side of the tank or by means of a pointer gauge. The discharge is computed as follows:

Initial fluid level reading $= H_1$ m
Final fluid ievel reading $= H_2$ m
Rise in fluid level $= H_2 - H_1$ m
Volume of fluid collected $= (H_2 - H_1) A$

where A is the area of cross-section of the tank in m^2.

Time period of collection = T minutes

∴ Discharge $$Q = \frac{(H_2 - H_1) A}{T \times 60} \text{ m}^3/\text{sec} \quad ...(1.2)$$

Flow of liquid should always be allowed for sometimes into the tank before taking measurements for flow rate.

(*c*) *Standard Flow Rate Meters, 'h'* is measured. From the calibration graph, *i.e.* a plot between Q and h of the meter, readily available in the laboratory Q is ascertained against the reading h so noted.

PART D : STUDY OF VARIOUS PRESSURE GAUGES

For measurement of pressure at a point or the difference of pressures between two points pressure gauges are deployed. Important ones being:

(*i*) Piezometer Tube (*ii*) U-Tube
(*iii*) Inverted U-Tube (*iv*) Differential Gauge
(*v*) Gauge with enlarged ends (*vi*) Inclined Tube Manometer.

(*i*) *Piezometer Tube.* A glass tube with open ends is inserted into pipe or vessel full of a liquid. It extends vertically upward to such a height that liquid can freely rise in it without overflowing. The liquid rises into the tube to a height equal to the equivalent static head of the pressure in the vessel. Such a simple type of pressure gauge is known as a piezometer tube. It is very commonly used in laboratories. For higher pressures piezo meteres may not be suitable. In that case, manormeters are employed for measuring pressure.

(*ii*) *U-Tube.* It consists of a glass U-tube containing a heavier fluid (*i.e.* having high specific gravity) which does not mix with the fluid of which the pressure is being measured. Its one end is connected to the gauge point and the other end remains open to the atmosphere.

Equating pressures at section XX, we get

$hS = (h_1 + h)1 + H$, where H is the pressure head

$$H = hS - h - h_1$$

$$H = h\,(S - 1) - h_1 \quad ...(1.3)$$

For measurement of large pressures mercury should be used in the U-tube; for small pressures the liquid should be little heavier than water only.

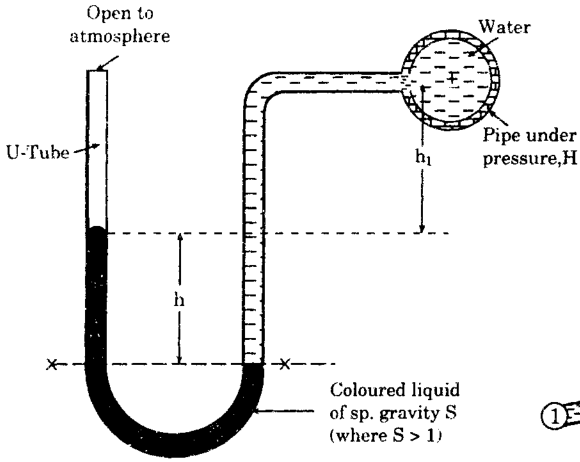

Fig. 1.5. U-Tube.

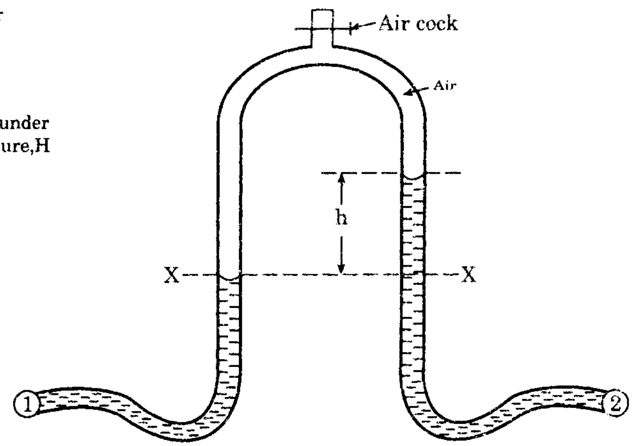

Fig. 1.6. Inverted U-Tube.

(*iii*) *Inverted U-Tube.* This is used for measuring the pressure difference between two points (1) and (2) in a pipe line carrying a fluid. The upper part of the tube contains air. The water column height can be adjusted to suitable heights by letting out air through the air cock at the top. The difference in the heights of the two columns gives the pressure difference. In case, the fluid is water then pressure difference between points 1 and 2 = h metre of water.

(*iv*) *Differential Gauge.* It is a modification to the inverted U-tube. The point of difference being that air is replaced by a liquid lighter than water. This makes the gauge sensitive; as is illustrated below. Refer to Fig. 1.6. Let S be the specific gravity of liquid used; the pressure difference between points (1) and (2) is

$$= h \text{ meter of water} - h \text{ meter of liquid}$$

$$= h - Sh = h\,(1 - S) \qquad \text{...(1.4)}$$

The instrument becomes more sensitive if S is near to unity.

(*v*) *Gauge with Enlarged Ends.* It is a U-tube with enlarged ends. It is sensitive gauge and is used for measuring small difference of pressure; even for gases. (Refer Fig. 1.7)

Equating pressures at the new surface YY, we get

$$H = h\left[1 + \frac{a}{A} - S\left(1 - \frac{a}{A}\right)\right] \qquad \text{...(1.5)}$$

(*vi*) *Inclined Tube Manometer.* It is a sensitive manometer used for measuring small pressure differences. (Refer Fig 1.8)

For a small pressure difference the distance i can be measured accurately whereas it is not possible to measure h with reasonable precision. Pressure $P = \rho\,\gamma l \sin\theta$. This type of a manometer calibrated to read pressure directly in case of water is known as a draft gauge.

(*i*) colourless fluid → reading (lower meniscus)
(*ii*) coloured fluid → reading (upper meniscus)

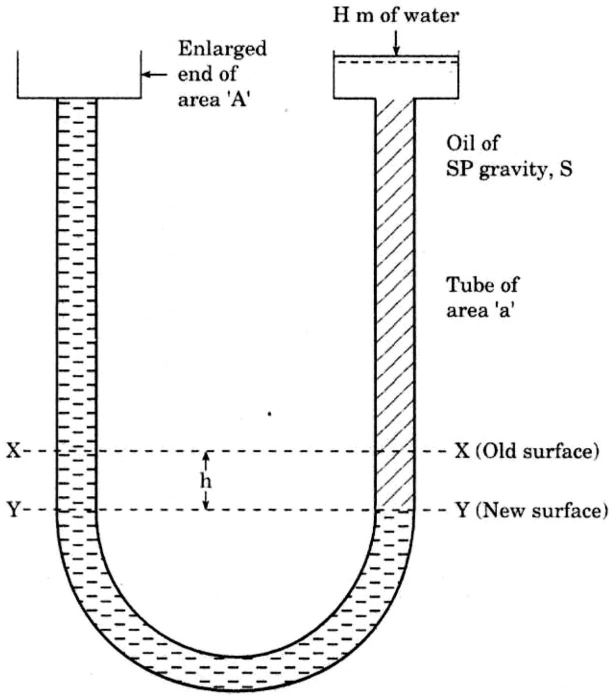

Fig. 1.7. Enlarged End Monometer

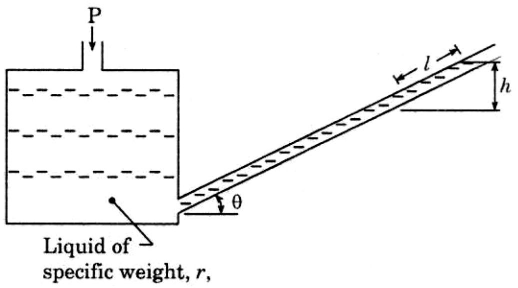

Fig. 1.8. Inclined Tube Manometer.

Think and Grow Rich

1. What is the difference between 'cohesion' and 'adhesion' as applied to fluid Mechanics?
2. What does **Pascal's Law** state?
3. Differentiate between simple and differential type of manometers.
4. What is the criteria for the choice of the manometric liquid in a manometer?
5. What is so special about a 'Single Column Manometer'?
6. Explain the purpose and principle of flow rate meters.
7. Define : (*i*) Open channel (*ii*) Canal (*iii*) Flume.