KOLEJ YAYASAN PELAJARAN JOHOR
FINAL EXAMINATION

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	DKM 2122
EXAMINATION	:	OCTOBER 2018
DURATION	:	2 HOURS

INSTRUCTION TO CANDIDATES

1. This examintaion paper consists **FIVE (5)** questions. Answer **FOUR (4)** questions only.

2. Candidates are not allowed to bring any material to examination room except with the permission from the invigilator.

3. Please check to make sure that this examination pack consist of:
   i. Question Paper
   ii. Answer Booklet

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This examination paper consists of 13 printed pages including front page

QUESTION 1/ *SOALAN 1*

Water is discharged from a reservoir into the atmosphere through a pipe 39 m long. There is a sharp entrance to the pipe and the diameter is 50 mm for the first 15 m from the entrance. The pipe then enlarges suddenly to 75 mm in diameter for the remainder of its length. Taking into account the loss of head at entry and at the enlargement, calculate the difference of level between the surface of the reservoir and the pipe exit which will maintain a flow of 2.8 dm^3/s. Take f as 0.0048 for the 50 mm pipe and 0.0058 for the 75 mm pipe.

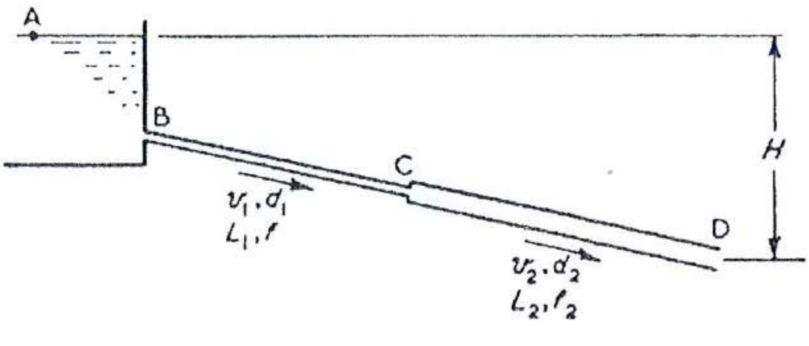


Figure 1/ Rajah 1

[15 MARKS/ *15 MARKAH*]

QUESTION 2/ *SOALAN 2*

a) A jet of water of 20 mm in diameter exists a nozzle directed vertically upwards at a velocity of 10 m/s. Assuming the jet retains a circular cross- section, determine the diameter (m) of the jet at a point 4.5 m above the nozzle exit. Take p_{water}= 1000 kg/m^3.

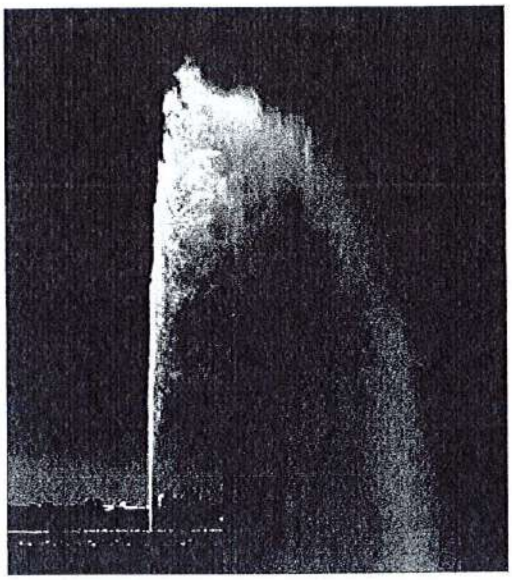


Figure 2/ Rajah 2

(8 marks/ markah)

b) Explain the meaning of Bernoulli equation and how it effects the flow of a liquid in a hydraulic circuit.

(3 marks/ markah)

c) Explain how a venturi is used to produce the Bernoulli effect in an automobile carburetor.

(4 marks/ markah)

[15 MARKS/ *15 MARKAH*]

QUESTION 3/ *SOALAN 3*

a) The absolute pressure in water at a depth of 8 m is read to be 175 kPa. Solve:

Bacaan tekanan mutlak air dengan kedalaman 8m adalah 175 kPa. Selesaikan

i. The local atmospheric pressure.
Tekanan atmosfera setempat.

(5 marks / *markah*)

ii. The absolute pressure at a depth of 8 m in a liquid whose specific gravity is 0.78 at the same location.
Tekanan mutlak cecair kedalaman 8 m di lokasi yang sama dengan graviti tentu 0.78.

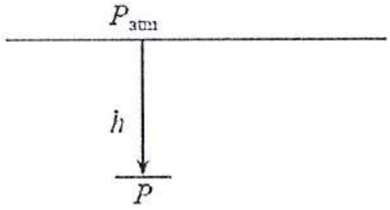


Figure 1/ *Rajah* 1

(3 marks / *markah*)

b) Make your complete analysis toward a milk tanker which completely filled with milk (no air space) and it accelerate at 4 m/s^2. If the minimum pressure in the tanker is 100 kPa, determine the maximum pressure difference and the location of the maximum pressure. Given, density of milk is 1020 kg/m^3, Diameter of tank cylinder is 3 m, length of tank cylinder is 7 m.

Buat analisis penuh terhadap sebuah lori tangki susu yang mana tangka tersebut diisi penuh (tanpa ruang udara) dan kadar pecutan adalah 4 m/s^2. Jika tekanan minima tangki adalah 100 kPa, nyatakan perbezaan tekanan maksima dan lokasi *tersebut. Diberi, ketumpatan susu adalah 1020 kg/m³, ukur lilit tangki silinder adalah 3 m, dan panjang tangki adalah 7 m.*

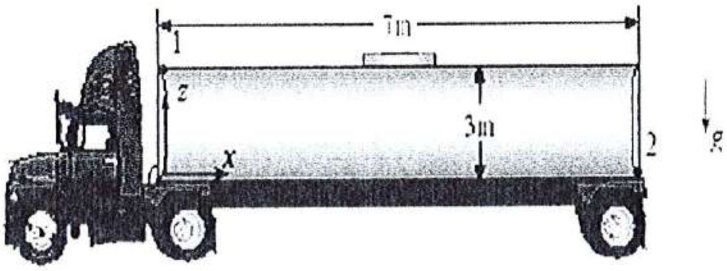


Figure 2 / *Rajah 2*

(7 marks / *markah*)

[15 MARKS/ *15 MARKAH*]

QUESTION 4/ *SOALAN 4*

a) Solve the following problem by using given data.
Selesaikan masalah berikut dengan menggunakan data yang di beri.

Volume of oil : 10 m^3 Weight : 50 000 N

i. Mass density, ρ in unit kg/m^3
Ketumpatan jisim, ρ dalam unit kg /m^3

(5 marks / *markah*)

ii. Specific weight, ω
Berat tentu, ω

(2 marks / *markah*)

iii. Specific gravity of oil, SG
Gravity tentu, SG

(3 marks / *markah*)

b) Solve when a bourdon pressure gauge attached to a boiler located at sea level shows a reading pressure of 10 bars. If atmospheric pressure is 1.01 bars,

Lakar dan selesaikan masalah berikut jika satu tolok tekanan bordon di pasang pada sebuah dandang yang terletak pada aras laut menunjukkan bacaan tekanan sebanyak 10 bars. Jika tekanan atmosfera adalah 1.01 bars, tentukan:

i. The absolute pressure in kN/m^2
Tekanan mutlak

(2 marks / *markah*)

ii. The pressure head of water, h
Tekanan air awalan

(3 marks / *markah*)

[15 MARKS/ *15 MARKAH*]

QUESTION 5/ *SOALAN 5*

a) Define the following terms:
Takrifkan istilah berikut:

i. Fluid
Bendalir

(1 marks / *markah*)

ii. Fluid statics
Bendalir statik

(1 marks / markah)

iii. Fluid dynamics
Bendalir dinamik

(1 marks / markah)

b) Explain the difference between the fluid in the liquid, gas and solid condition.
Terangkan perbezaan antara bendalir dalam keadaan cecair, gas dan pepejal.

(3 marks / 3 *markah*)

c) A Bourdon pressure gauge is attached to a boiler which is located at sea level with a reading preassure of 7 bar. If atmospheric pressure is 1.013 bar, calculate the absolute pressure in that boiler (in kN/m^2).
Satu tolok tekanan Bourdon di pasangkan pada sebuah dandang yang terletak di atas aras laut menunjukkan tekanan sebanyak 7 bar. Jika tekanan atmosfera adalah 1.013 bar, kirakan tekanan mutlak dalam dandang tersebut (dalam kN/m^2).

(7 marks / 7 *markah*)

d) Give the different between incompressible and compressible flow.

Berikan perbezaan diantara bendalir tidak boleh mampat dan boleh mampat.

(2 marks/ markah)

[15 MARKS/ *15 MARKAH*]

END OF QUESTION PAPER/ *KERTAS SOALAN TAMAT*

FORMULA

Density :

$\rho = m/v$

Pressure :

$P = F / A$

$P = \rho g h$

$P = P_0 - \rho g h$

$P_{gage} = P_{abs} - P_{atm}$

$P_{vac} = P_{atm} - P_{abs}$

$P_{abs} = P_{gage} - P_{atm}$

Specific Gravity : $\gamma_{substance} / \gamma_{water}$

Specific Weight,W : ρg

Heat, Q : $C_p\, m\, dT$

Langarian and Eularian :

$$\bar{a} = \frac{d\bar{V}}{dt} = \frac{\partial \bar{V}}{\partial t}\frac{dt}{dt} + \frac{\partial \bar{V}}{\partial x}\frac{dx}{dt} + \frac{\partial \bar{V}}{\partial y}\frac{dy}{dt} + \frac{\partial \bar{V}}{\partial z}\frac{dz}{dt}$$

$$= \frac{\partial \bar{V}}{\partial t}(1) + \frac{\partial \bar{V}}{\partial x}(u) + \frac{\partial \bar{V}}{\partial y}(v) + \frac{\partial \bar{V}}{\partial z}(w)$$

$$= \frac{\partial \bar{V}}{\partial t} + u\frac{\partial \bar{V}}{\partial x} + v\frac{\partial \bar{V}}{\partial y} + w\frac{\partial \bar{V}}{\partial z}$$

Fluid dynamics :

$$\frac{P_1}{\omega} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\omega} + \frac{v_2^2}{2g} + z_2$$

$$Q_{actual} = C_d \times A_1 \sqrt{\frac{2gH}{(m^2 - 1)}}$$

$$Q_{actual} = \frac{C_d \times A_1}{\sqrt{(m^2 - 1)}} \sqrt{2g\left[\frac{P_1 - P_2}{\omega} + (z_1 - z_2)\right]}$$

Energy losses in pipes :

$$h_C = \left[\frac{1}{Cc} \quad 1\right]^2 \times \frac{v_2^2}{2g}$$

$$h_i = 0.5\frac{v_2^2}{2g}$$

$$h_F = \frac{4fl}{d}\frac{v^2}{2g}$$

$$h_L = \frac{(V_1 - V_2)^2}{2g}$$

Nozzle :

$$\frac{P_c}{P_1} = \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma+1}}$$

$$\frac{T_C}{T_1} = \frac{2}{\gamma+1}$$

$$\frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^{\frac{\gamma-1}{\gamma}}$$

$$V_C = \frac{RT_C}{P_C} \quad A_C = \frac{\dot{m}V_C}{C_c}$$

Coefficient of Volume Expansion

Constant : P / p

Specific heat at constant pressure, k : C_p/C_v

Absolute Viscosity : (F/A) / (v/y)

Kinematic Viscosity, V : μ / p

Hydraulic : $F_1 / A_1 = F_2 / A_2$

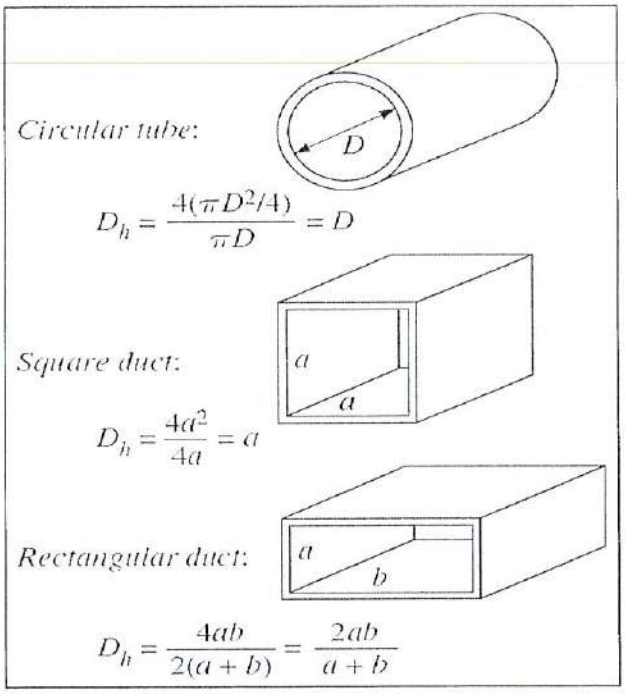
$F_2 / A_2 = A_2 / A_1$

$P_1 = P_2$

Buoyancy : Momen inertia from surface / volume of water displaced

Bernoulli :

$P_1 / p + V_1^2 / 2 + gz_1 = P_2 /p + V_2^2 + gz_2$

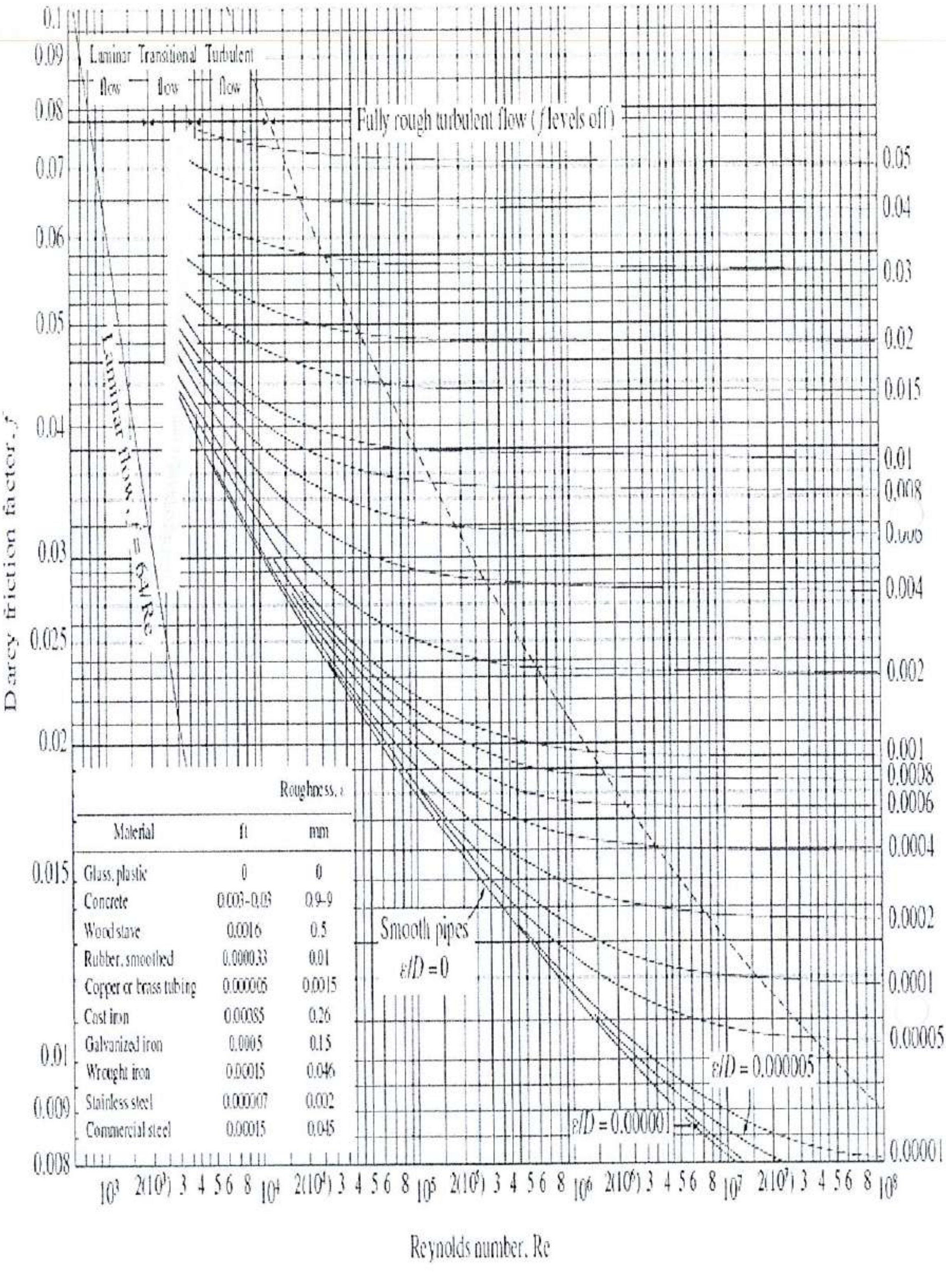


Relative Roughness, ε/D	Friction Factor, f
0.0*	0.0119
0.00001	0.0119
0.0001	0.0134
0.0005	0.0172
0.001	0.0199
0.005	0.0305
0.01	0.0380
0.05	0.0716

* Smooth surface. All values are for Re = 10^6 and are calculated from the Colebrook equation.

Equivalent roughness values for new commercial pipes*

Material	Roughness, ε ft	Roughness, ε mm
Glass, plastic	0 (smooth)	
Concrete	0.003–0.03	0.9–9
Wood stave	0.0016	0.5
Rubber, smoothed	0.000033	0.01
Copper or brass tubing	0.000005	0.0015
Cast iron	0.00085	0.26
Galvanized iron	0.0005	0.15
Wrought iron	0.00015	0.046
Stainless steel	0.000007	0.002
Commercial steel	0.00015	0.045


Laminar flow
Transitional flow
Turbulent flow
Fully rough turbulent flow (f levels off)
Laminar flow, f = 64/Re
Darcy friction factor, f
Relative roughness, ε/D
Smooth pipes ε/D = 0
ε/D = 0.000005
ε/D = 0.000001
Reynolds number, Re
Roughness, ε
Material | ft | mm
Glass, plastic | 0 | 0
Concrete | 0.003–0.03 | 0.9–9
Wood stave | 0.0016 | 0.5
Rubber, smoothed | 0.000033 | 0.01
Copper or brass tubing | 0.000005 | 0.0015
Cast iron | 0.00085 | 0.26
Galvanized iron | 0.0005 | 0.15
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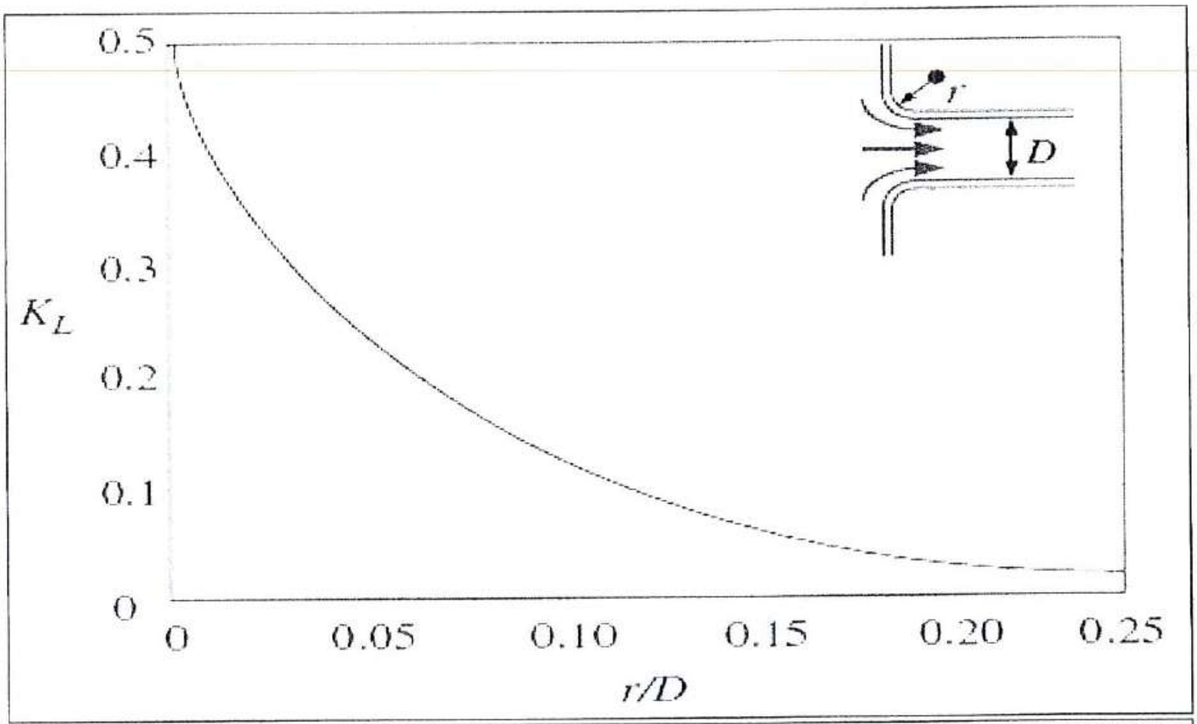
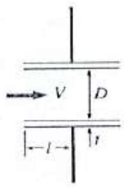


TABLE 14–3

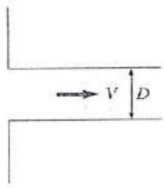
Loss coefficients K_L of various pipe components for turbulent flow (for use in the relation $h_L = K_L V^2/(2g)$, where V is the average velocity in the pipe that contains the component)*

Pipe Inlet

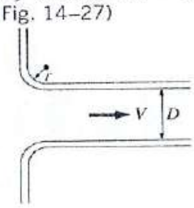
Reentrant: $K_L = 0.80$
($t \ll D$ and $l \approx 0.1D$)



Sharp-edged: $K_L = 0.50$

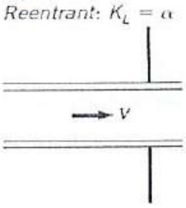


Well-rounded ($r/D > 0.2$): $K_L = 0.03$
Slightly rounded ($r/D = 0.1$): $K_L = 0.12$
(see Fig. 14–27)

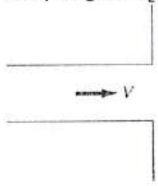


Pipe Exit

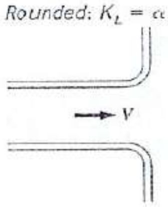
Reentrant: $K_L = \alpha$



Sharp-edged: $K_L = \alpha$



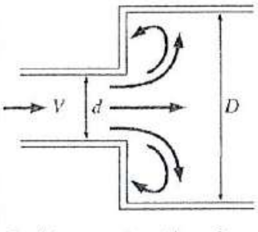
Rounded: $K_L = \alpha$



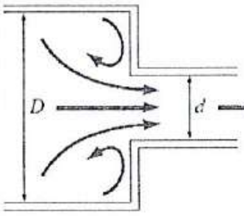
Note: The kinetic energy correction factor is $\alpha = 2$ for fully developed laminar flow, and $\alpha \approx 1.05$ for fully developed turbulent flow.

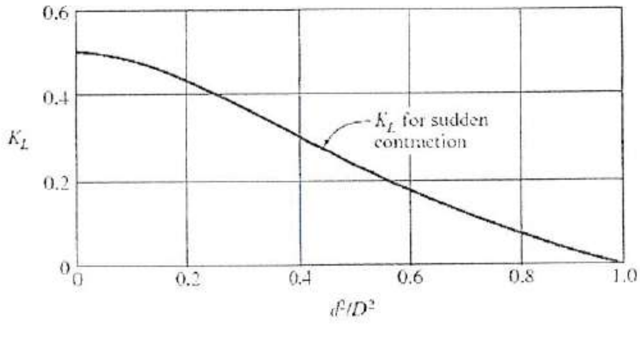
Sudden Expansion and Contraction (based on the velocity in the smaller-diameter pipe)

Sudden expansion: $K_L = \alpha\left(1 - \frac{d^2}{D^2}\right)^2$



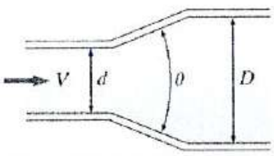
Sudden contraction: See chart.



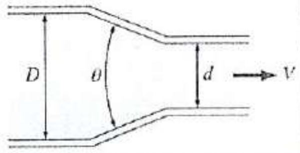


Gradual Expansion and Contraction (based on the velocity in the smaller-diameter pipe)

Expansion (for $\theta = 20°$):
$K_L = 0.30$ for $d/D = 0.2$
$K_L = 0.25$ for $d/D = 0.4$
$K_L = 0.15$ for $d/D = 0.6$
$K_L = 0.10$ for $d/D = 0.8$

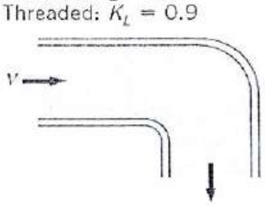


Contraction:
$K_L = 0.02$ for $\theta = 30°$
$K_L = 0.04$ for $\theta = 45°$
$K_L = 0.07$ for $\theta = 60°$

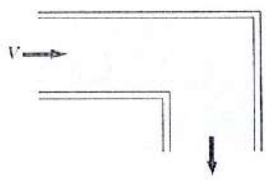


Bends and Branches

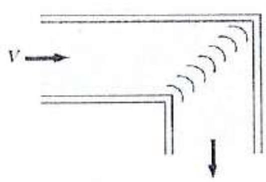
90° smooth bend:
Flanged: $K_L = 0.3$
Threaded: $K_L = 0.9$



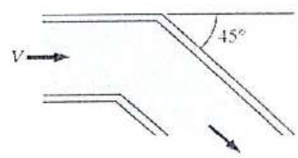
90° miter bend (without vanes): $K_L = 1.1$



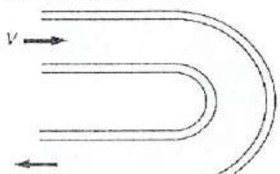
90° miter bend (with vanes): $K_L = 0.2$



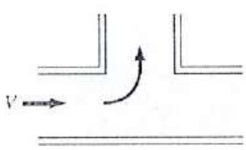
45° threaded elbow: $K_L = 0.4$



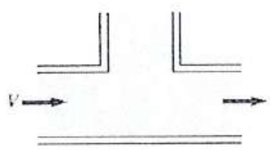
180° return bend:
Flanged: $K_L = 0.2$
Threaded: $K_L = 1.5$



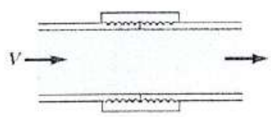
Tee (branch flow):
Flanged: $K_L = 1.0$
Threaded: $K_L = 2.0$



Tee (line flow):
Flanged: $K_L = 0.2$
Threaded: $K_L = 0.9$



Threaded union: $K_L = 0.08$



Valves

Globe valve, fully open: $K_L = 10$
Angle valve, fully open: $K_L = 5$
Ball valve, fully open: $K_L = 0.05$
Swing check valve: $K_L = 2$

Gate valve, fully open: $K_L = 0.2$
$\frac{1}{4}$ closed: $K_L = 0.3$
$\frac{1}{2}$ closed: $K_L = 2.1$
$\frac{3}{4}$ closed: $K_L = 17$

* These are representative values for loss coefficients. Actual values strongly depend on the design and manufacture of the components and may differ from the given values considerably (especially for valves). Actual manufacturer's data should be used in the final design.