



UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2011 SESSION

SUBJECT CODE	:	FCD 20102
SUBJECT TITLE	:	FLUID MECHANICS
LEVEL	:	DIPLOMA
TIME / DURATION	:	9.00am – 11.00am (2 HOURS)
DATE	:	06 MAY 2011

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer two (2) question only.
6. Answer all questions in English.
7. Formula is appended.

THERE ARE 6 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 60 marks)**INSTRUCTION: Answer ALL questions.****Please use the answer booklet provided.****Question 1**

- (a) What is the definition of Liquid? (4 marks)
- (b) What is the definition of Gasses? (4 marks)
- (c) What is the definition and unit of pressure? (4 marks)
- (d) What is the definition and unit of temperature? (4 marks)
- (e) What is the definition and unit of specific gravity? (4 marks)

Question 2

- (a) What is the definition of absolute pressure?
(2 marks)
- (b) What is the definition of Gauge Pressure?
(2 marks)
- (c) A gas contained in a vertical, frictionless piston-cylinder device. The piston has a mass of 5 kg and a cross section area of 25 cm^2 . a compressed spring above the piston exerts a force of 75N on the piston. If the atmospheric pressure is 98 kPa, determine the pressure inside the cylinder
(16 marks)

$$F_{\text{spring}} = 75 \text{ N}$$

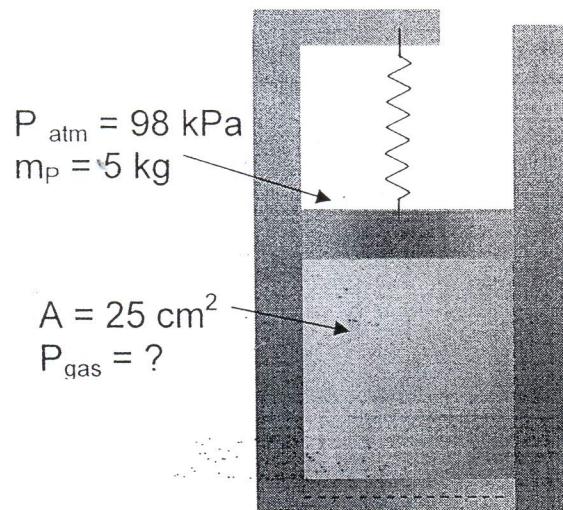


Figure Q2(c): cylinder piston

Question 3

- (a) What is the difference between gauge pressure and absolute pressure?
(5 marks)
- (b) The manometer is used to measure the pressure in the tank. The fluid 'B' used has a specific gravity of 1.50, and the manometer height is 55cm, local atmospheric pressure is 96kPa.
- Determine the density of fluid B.
(5 marks)
 - Determine the absolute pressure within the tank.
(10 marks)

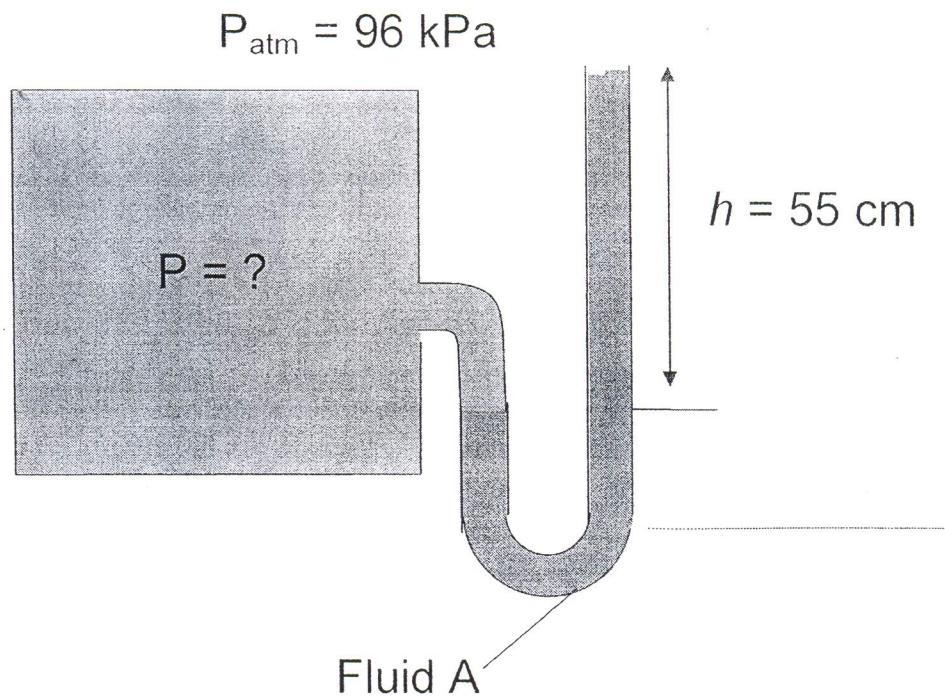


Figure Q3: Manometer

SECTION B (Total: 40 marks)**INSTRUCTION:** Answer only TWO questions.

Please use the answer booklet provided.

Question 4

The mercury manometer, shown in figure Q4, is used to measure the pressure between two conduits A and B. The specific gravity of air is 0.1529, specific gravity of mercury is 13.6 and pressure at Point A is 50kPa.

- (a) Determine the specific weight of air? (5 marks)
- (b) Determine the specific weight of Mercury? (5 marks)
- (c) What is the pressure at point B? (10 marks)

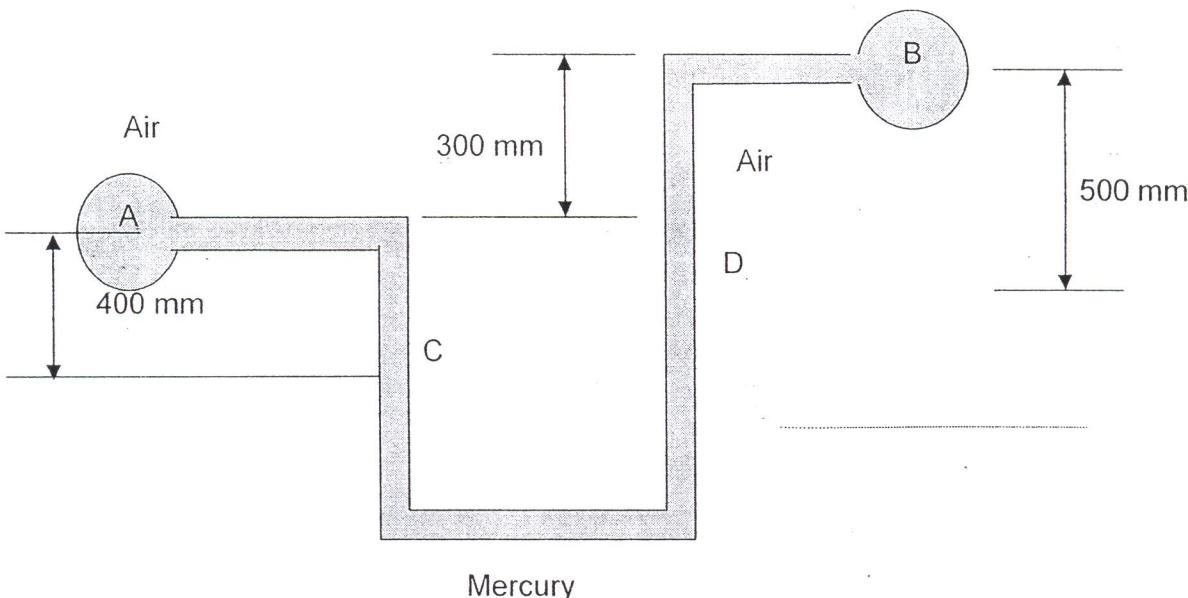


Figure Q4: Mercury manometer

Question 5

The oil piping system delivered the oil by motor, the volume flow rate is $0.25\text{m}^3/\text{s}$, Energy loss of 1.4N.m/N in the piping system if the motor has an efficiency of 75%

- (a) Determine the velocity at point 2. (5 marks)
- (b) Determine the power delivered by the motor. (10 marks)
- (c) Determine the power output by the motor. (5 marks)

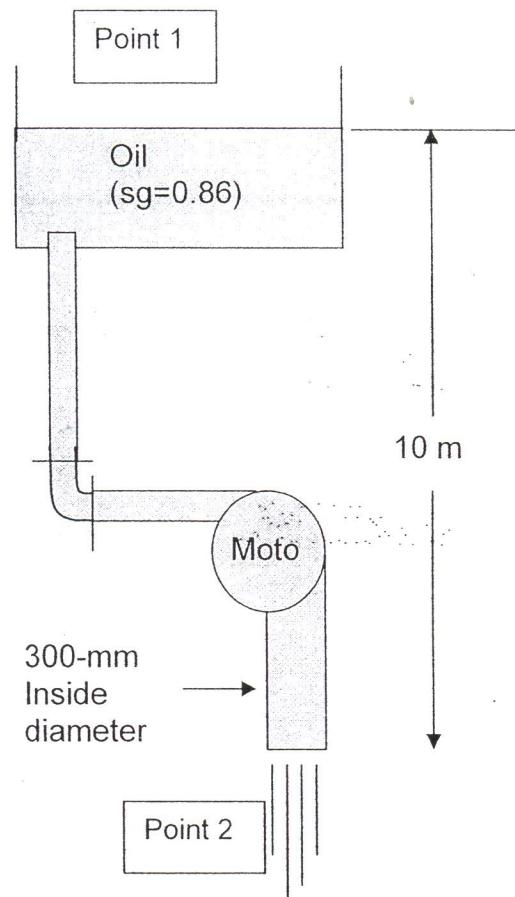


Figure Q5: Oil piping system

Question 6

Figure Q6 is a section of condenser with copper duct as shown. Carbon dioxide with a specific weight of $0.114 \text{ lb}/\text{ft}^3$ and a dynamic viscosity of $3.34 \times 10^{-7} \text{ lb}\cdot\text{s}/\text{ft}^2$ flows into the copper duct. If the volume flow rate is $100 \text{ ft}^3/\text{min}$ for each duct,

- (a) Determine the duct area. (3 marks)
- (b) Determine the duct wetted parameter. (3 marks)
- (c) Determine the Hydraulic radius. (4 marks)
- (d) Determine the Reynolds number ducting flow for this system. (10 marks)

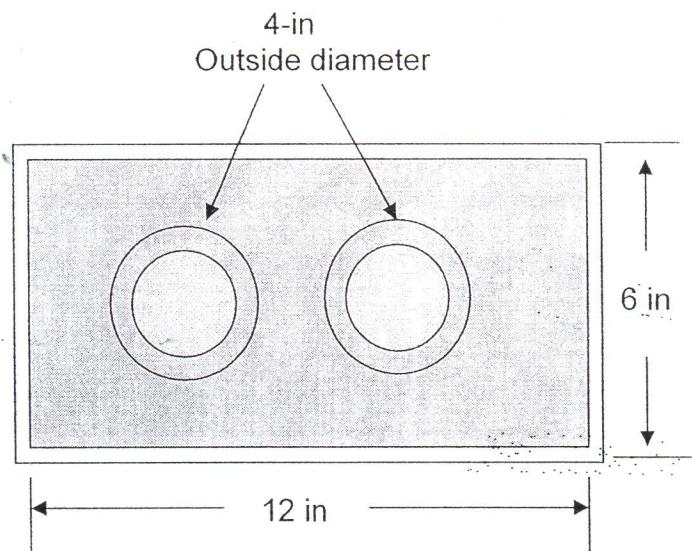


Figure Q6: Structure of the Condenser

END OF QUESTION

Appendix Technical Document

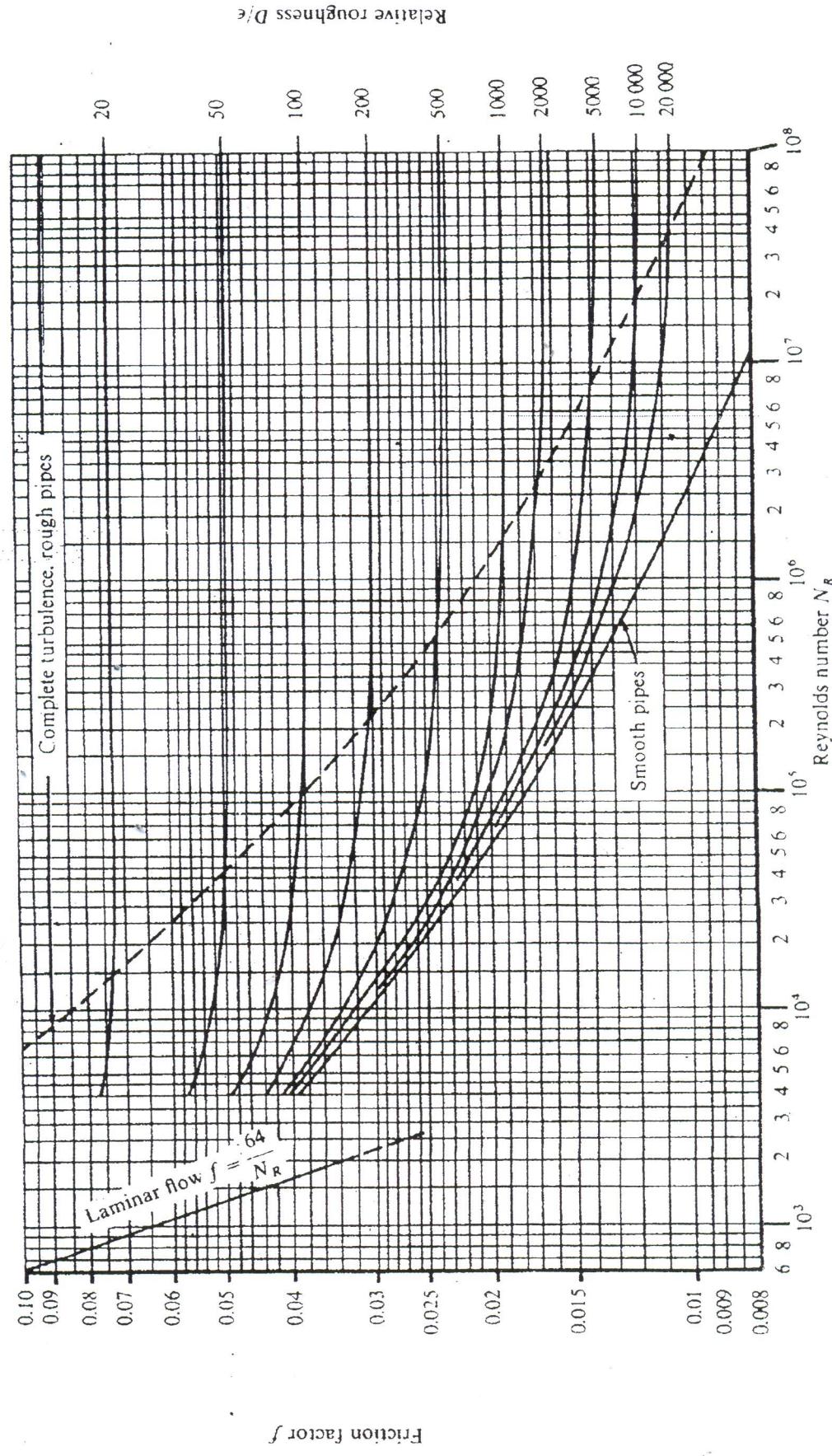


FIGURE 9.2
Moody's diagram. (Source: Pao, R. H. F. 1961. *Fluid Mechanics*. New York: John Wiley & Sons, p. 284)

Table of water properties in SI unit

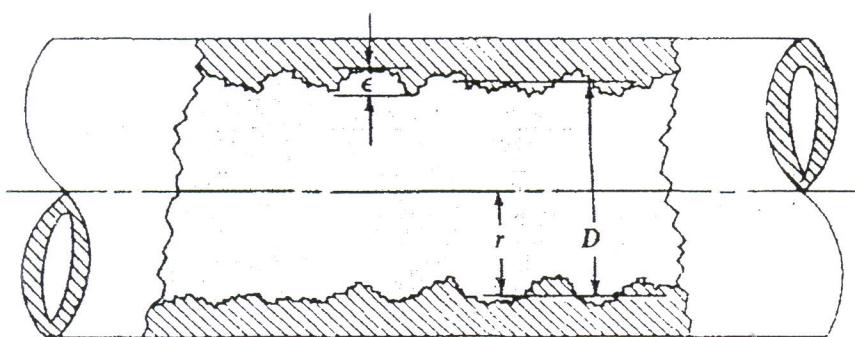
TABLE A.1
SI Units [101 kPa (abs)]

Temperature (°C)	Specific Weight γ (kN/m³)	Density ρ (kg/m³)	Dynamic Viscosity μ (Pa·s) or (N·s/m²)	Kinematic Viscosity ν (m²/s)
0	9.81	1000	1.75×10^{-3}	1.75×10^{-6}
5	9.81	1000	1.52×10^{-3}	1.52×10^{-6}
10	9.81	1000	1.30×10^{-3}	1.30×10^{-6}
15	9.81	1000	1.15×10^{-3}	1.15×10^{-6}
20	9.79	998	1.02×10^{-3}	1.02×10^{-6}
25	9.78	997	8.91×10^{-4}	8.94×10^{-7}
30	9.77	996	8.00×10^{-4}	8.03×10^{-7}
35	9.75	994	7.18×10^{-4}	7.22×10^{-7}
40	9.73	992	6.51×10^{-4}	6.56×10^{-7}
45	9.71	990	5.94×10^{-4}	6.00×10^{-7}
50	9.69	988	5.41×10^{-4}	5.48×10^{-7}
55	9.67	986	4.98×10^{-4}	5.05×10^{-7}
60	9.65	984	4.60×10^{-4}	4.67×10^{-7}
65	9.62	981	4.31×10^{-4}	4.39×10^{-7}
70	9.59	978	4.02×10^{-4}	4.11×10^{-7}
75	9.56	975	3.73×10^{-4}	3.83×10^{-7}
80	9.53	971	3.50×10^{-4}	3.60×10^{-7}
85	9.50	968	3.30×10^{-4}	3.41×10^{-7}
90	9.47	965	3.11×10^{-4}	3.22×10^{-7}
95	9.44	962	2.92×10^{-4}	3.04×10^{-7}
100	9.40	958	2.82×10^{-4}	2.94×10^{-7}

Table of water properties in US unit

TABLE A.2
U.S. Customary System Units (14.7 psia)

Temperature (°F)	Specific Weight γ (lb/ft ³)	Density ρ (slugs/ft ³)	Dynamic Viscosity μ (lb-s/ft ²)	Kinematic Viscosity ν (ft ² /s)
32	62.4	1.94	3.66×10^{-5}	1.89×10^{-5}
40	62.4	1.94	3.23×10^{-5}	1.67×10^{-5}
50	62.4	1.94	2.72×10^{-5}	1.40×10^{-5}
60	62.4	1.94	2.35×10^{-5}	1.21×10^{-5}
70	62.3	1.94	2.04×10^{-5}	1.05×10^{-5}
80	62.2	1.93	1.77×10^{-5}	9.15×10^{-6}
90	62.1	1.93	1.60×10^{-5}	8.29×10^{-6}
100	62.0	1.93	1.42×10^{-5}	7.37×10^{-6}
110	61.9	1.92	1.26×10^{-5}	6.55×10^{-6}
120	61.7	1.92	1.14×10^{-5}	5.94×10^{-6}
130	61.5	1.91	1.05×10^{-5}	5.49×10^{-6}
140	61.4	1.91	9.60×10^{-6}	5.03×10^{-6}
150	61.2	1.90	8.90×10^{-6}	4.68×10^{-6}
160	61.0	1.90	8.30×10^{-6}	4.38×10^{-6}
170	60.8	1.89	7.70×10^{-6}	4.07×10^{-6}
180	60.6	1.88	7.23×10^{-6}	3.84×10^{-6}
190	60.4	1.88	6.80×10^{-6}	3.62×10^{-6}
200	60.1	1.87	6.25×10^{-6}	3.35×10^{-6}
212	59.8	1.86	5.89×10^{-6}	3.17×10^{-6}

**FIGURE 9.1**

Pipe wall roughness.

TABLE 9.1

Pipe roughness—Design values

Material	Roughness, ϵ (m)	Roughness, ϵ (ft)
Glass, plastic	Smooth	Smooth
Copper, brass, lead (tubing)	1.5×10^{-6}	5×10^{-6}
Cast iron—uncoated	2.4×10^{-4}	8×10^{-4}
Cast iron—asphalt coated	1.2×10^{-4}	4×10^{-4}
Commercial steel or welded steel	4.6×10^{-5}	1.5×10^{-4}
Wrought iron	4.6×10^{-5}	1.5×10^{-4}
Riveted steel	1.8×10^{-3}	6×10^{-3}
Concrete	1.2×10^{-3}	4×10^{-3}

Dimensions of steel pipe

Table F.1
Schedule 40 (SI unit)

Nominal Pipe Size (in)	Outside Diameter (mm)	Inside Diameter (mm)	Wall Thickness (mm)	Flow Area (m ²)
1/8	10.3	6.8	1.73	3.660 x 10-5
1/4	13.7	9.2	2.24	6.717 x 10-5
3/8	17.1	12.5	2.31	1.236 x 10-4
1/2	21.3	15.8	2.77	1.960 x 10-4
3/4	26.7	20.9	2.87	3.437 x 10-4
1	33.4	26.6	3.38	5.574 x 10-4
1, 1/4	42.2	35.1	3.56	9.653 x 10-4
1, 1/2	48.3	40.9	3.68	1.314 x 10-3
2	60.3	52.5	3.91	2.168 x 10-3
2, 1/2	73.0	62.7	5.16	3.090 x 10-3
3	88.9	77.9	5.49	4.768 x 10-3
3, 1/2	101.6	90.1	5.74	6.381 x 10-3
4	114.3	102.3	6.02	8.213 x 10-3
5	141.3	128.2	6.55	1.291 x 10-2
6	168.3	154.1	7.11	1.864 x 10-2
8	219.1	202.7	8.18	3.226 x 10-2
10	273.1	254.5	9.27	5.090 x 10-2
12	323.9	303.2	10.31	7.219 x 10-2
14	355.6	333.4	11.10	8.729 x 10-2
16	406.4	381.0	12.7	0.1140
18	457.2	428.7	14.27	0.1443
20	508.0	477.9	15.06	0.1794
24	609.6	574.7	17.45	0.2594

Dimensions of steel pipe

Table F.2
Schedule 40 (U.S Customary system Unit)

Nominal Pipe Size (in)	Outside Diameter (in)	Inside Diameter (in)	Wall Thickness (ft)	Flow Area (in ²)	Flow Area (ft ²)
1/8	0.405	0.269	0.0224	0.068	0.000394
1/4	0.540	0.364	0.0303	0.088	0.000723
3/8	0.675	0.493	0.0411	0.091	0.00133
1/2	0.840	0.622	0.0518	0.109	0.00211
3/4	1.050	0.824	0.0687	0.113	0.0037
1	1.315	1.049	0.0874	0.133	0.006
1 1/4	1.660	1.380	0.1150	0.140	0.01039
1 1/2	1.900	1.610	0.1342	0.145	0.01414
2	2.375	2.067	0.1723	0.154	0.02333
2 1/2	2.875	2.469	0.2058	0.203	0.03326
3	3.500	3.068	0.2557	0.216	0.05132
3 1/2	4.000	3.548	0.2957	0.226	0.06868
4	4.500	4.026	0.3355	0.237	0.0884
5	5.563	5.047	0.4206	0.258	0.139
6	6.625	6.065	0.5054	0.280	0.2006
8	8.625	7.981	0.6651	0.322	0.3472
10	10.750	10.020	0.8350	0.365	0.5479
12	12.750	11.938	0.9948	0.406	0.7771
14	14.000	13.126	1.0940	0.437	0.9396
16	16.000	15.000	1.2500	0.500	1.227
18	18.000	16.876	1.4060	0.562	1.553
20	20.000	18.814	1.3680	0.593	1.931
24	24.000	22.626	1.8860	0.687	2.792

Dimensions of Copper Tubing

Table H.1
Type K (Recommended for underground service and general plumbing)

Nominal Pipe Size (in)	Outside Diameter (mm)	Inside Diameter (mm)	Wall Thickness (mm)	Flow Area
				(m ²)
1/4	9.5	7.7	0.89	4.710×10^{-5}
3/8	12.7	10.2	1.24	8.185×10^{-4}
1/2	15.9	13.4	1.24	1.408×10^{-4}
5/8	19.1	16.6	1.24	2.154×10^{-4}
3/4	22.2	18.9	1.65	2.812×10^{-4}
1	28.6	25.3	1.65	5.017×10^{-4}
1 1/4	34.9	31.6	1.65	7.854×10^{-4}
1 1/2	41.3	37.6	1.83	1.111×10^{-3}
2	54.0	49.8	2.11	1.945×10^{-3}
2 1/2	66.7	61.8	2.41	3.005×10^{-3}
3	79.4	73.8	2.77	4.282×10^{-3}
3 1/2	92.1	86.0	3.05	5.806×10^{-3}
4	104.8	98.0	3.40	
5	130.2	122.0	4.06	
6	155.6	145.8	4.88	
8	206.4	192.6	6.88	
10	257.2	240.0	8.59	
12	308.0	287.4	10.29	

Formula:

$1\text{in} = 0.0254\text{m}$, $1000\text{L} = 1\text{m}^3$

$P_{abs} = P_{atm} + P_{gauge}$

$P = \frac{F}{A}$ where P=Pressure, F=Force, A=C/S Area

$S.G_s = \frac{\rho_s}{\rho_{water @ 4^\circ C}}$ where S.G= spec.Gravity, ρ_s =density substance

$S.G_s = \frac{\gamma_s}{\gamma_{water @ 4^\circ C}}$ where S.G= spec.Gravity, γ = specific weight

$\gamma = \rho g$ where ρ =density, g=gravity

$Q = A v$ where Q=Volume flow ,rate A=C/S area, v= speed

$\rho = \frac{m}{V}$ where ρ =density, m=mass, V=Volume

$M = \rho A v$ where M=mass flow rate, ρ = density

$W = \rho g V$ where W=weight, V=Volume

$W = \gamma Q$ where W=weight flow rate, γ = specific weight

$P = \rho g h$ where P= pressure, g=gravity, h= height

Conservation of energy: $\frac{p_1}{\gamma} + z_1 + \frac{v_1^2}{2g} = \frac{p_2}{\gamma} + z_2 + \frac{v_2^2}{2g}$

General energy equation: $\frac{p_1}{\gamma} + z_1 + \frac{v_1^2}{2g} + h_A - h_R - h_L = \frac{p_2}{\gamma} + z_2 + \frac{v_2^2}{2g}$

Power : $P_A = h_A W = h_A \gamma Q; P_R = h_R W = h_R \gamma Q$

where P_A =Added Power, P_R =Removed Power

mechanical efficiency: $e_M = \frac{P_A}{P_i}; e_M = \frac{P_o}{P_R}$

where P_i =power input, P_o =power output

Reynold's number: $N_R = \frac{vD\rho}{\mu} = \frac{vD}{\nu}$

$h_L = \frac{32\mu Lv}{\gamma D_2} = f \times \frac{L}{D} \times \frac{v^2}{2g}$

minor loss: $h_L = \frac{C_L v_1^2}{2g}$

loss coefficient: $C_L = \left[1 - \left(\frac{A_1}{A_2} \right)^2 \right]$