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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2010 SESSION

SUBJECT CODE	:	FCD 20102
SUBJECT TITLE	:	FLUID MECHANICS
LEVEL	:	DIPLOMA
TIME / DURATION	:	3.00pm – 5.00pm (2 HOURS)
DATE	:	30 APRIL 2010

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 questions paper consists of TWO (2) sections. Section A and B. Answer ALL questions in section A. For Section B answer TWO (2) questions only.
6. Answer all questions in English.
7. *Formula is appended.*

THERE ARE 6 PAGES OF QUESTIONS AND 8 PAGES OF APPENDIX , EXCLUDING THIS PAGE.

SECTION A (Total: 60 marks)

INSTRUCTION: Answer ALL questions.
Please use the answer booklet provided.

Question 1

a) State the difference between liquid and gases ?

(4 marks)

b) What is difference between mass (m) and weight (w) ?

(2 marks)

c) What is the standard value for gravity and specific weight in SI and US unit ?

(4 marks)

d) Calculate the weight of a reservoir of oil if it has a mass of 825 kg, Write the final answer in kN .

(4 marks)

e) If the reservoir from question 1(d) has a volume of $0.917 m^3$, compute the density, specific weight and specific gravity of the oil.

(6 marks)

Question 2

a) Define “Dynamic viscosity” and “Kinematic viscosity” ?

(4 marks)

b) Derive the units for Kinematic viscosity by substituting from the formula $v = \mu / p$

(10 marks)

c) An infinite plate is moved over a second plate on a layer of fluid. The liquid viscosity is 0.65 g/cm.sec and specific gravity is 0.75 Calculate : -

i) The dynamic viscosity in kg/m.sec

(3 marks)

ii) The Kinematic viscosity of the liquid.

(3 marks)

Question 3

a) Define the relationship between "absolute pressure , gauge pressure and atmospheric pressure" ?

(4 marks)

b) A vacuum gauge connected to a chamber reads 5.8psi at location where the atmospheric pressure is 14.5psi. Determine the absolute pressure in the chamber.

(2 marks)

C) Figure Q3 shows a closed tank that contains gasoline floating on water. Calculate the air pressure above the gasoline.

(14 marks)

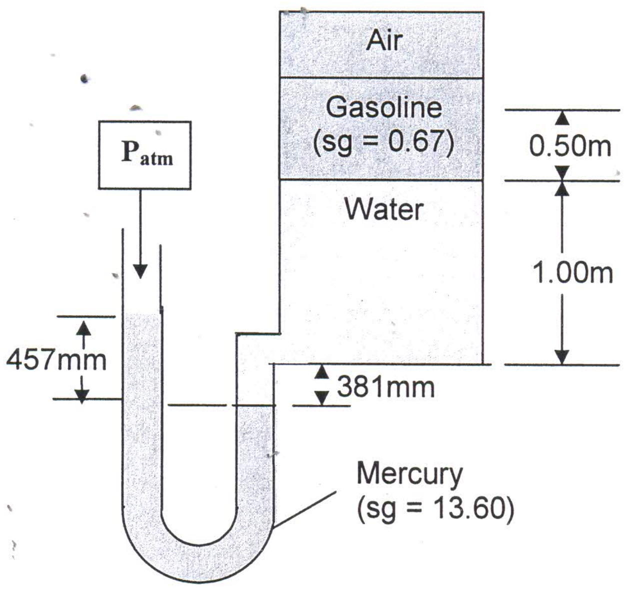

Figure Q3: Water tank

SECTION B (Total: 40 marks)

INSTRUCTION: Answer only TWO questions.
Please use the answer booklet provided.

Question 4

For the differential manometer shown in figure Q4, calculate the pressure difference between point A and B. The specific gravity of the oil is 0.85

(20 marks)

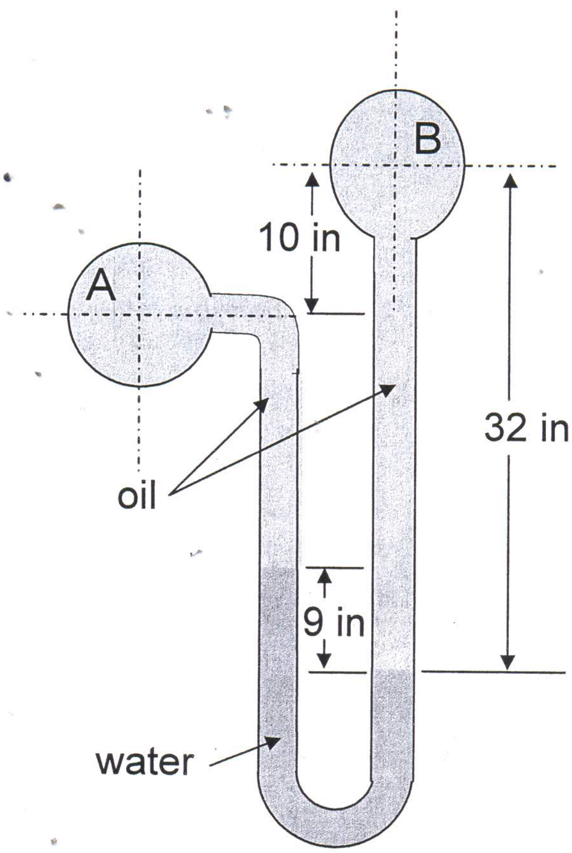

Figure Q4 : Manometer

Question 5

The pump shown in figure Q5 is delivering hydraulic oil with a specific gravity at 0.85 at rate of 75 L/min. The pressure at A is -20kPa while the pressure at B is 275kPa. The energy loss in the system is 2.5 times the velocity head in the discharge pipe. Calculate the power delivered by the pump to the oil.

(20 marks)

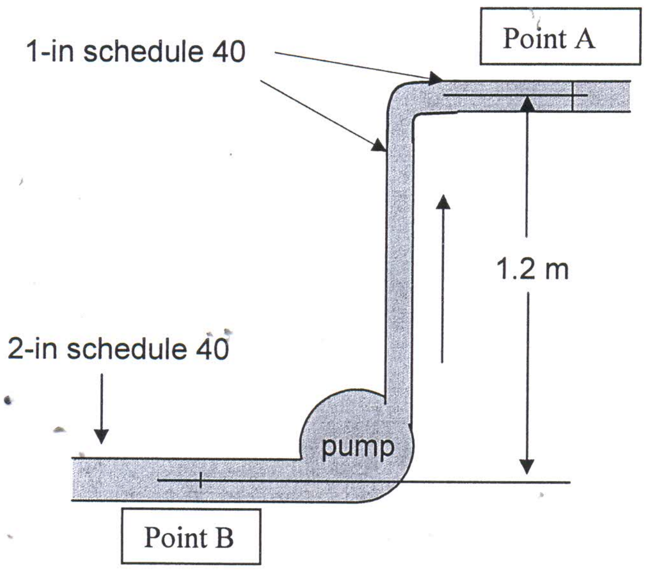

Figure Q5 : Pump hydraulic piping

Question 6

Water at 10°c is flowing in the shell shown in figure Q6 at the rate of 850 L/min. The shell is a 2-in Type L copper tube, while the tubes are 3/8-in. Compute the Reynolds Number for the flow.

(20 marks)

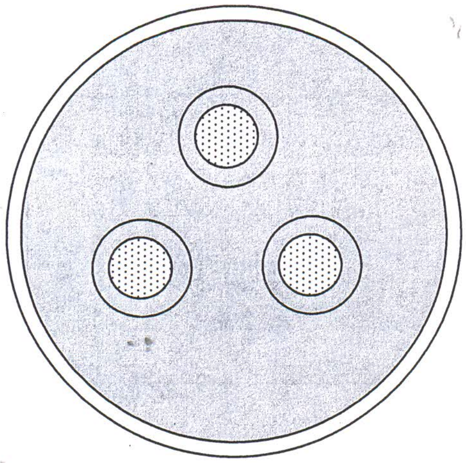

Figure Q6: Structure of the Condenser

END OF QUESTION

Appendix Technical Document

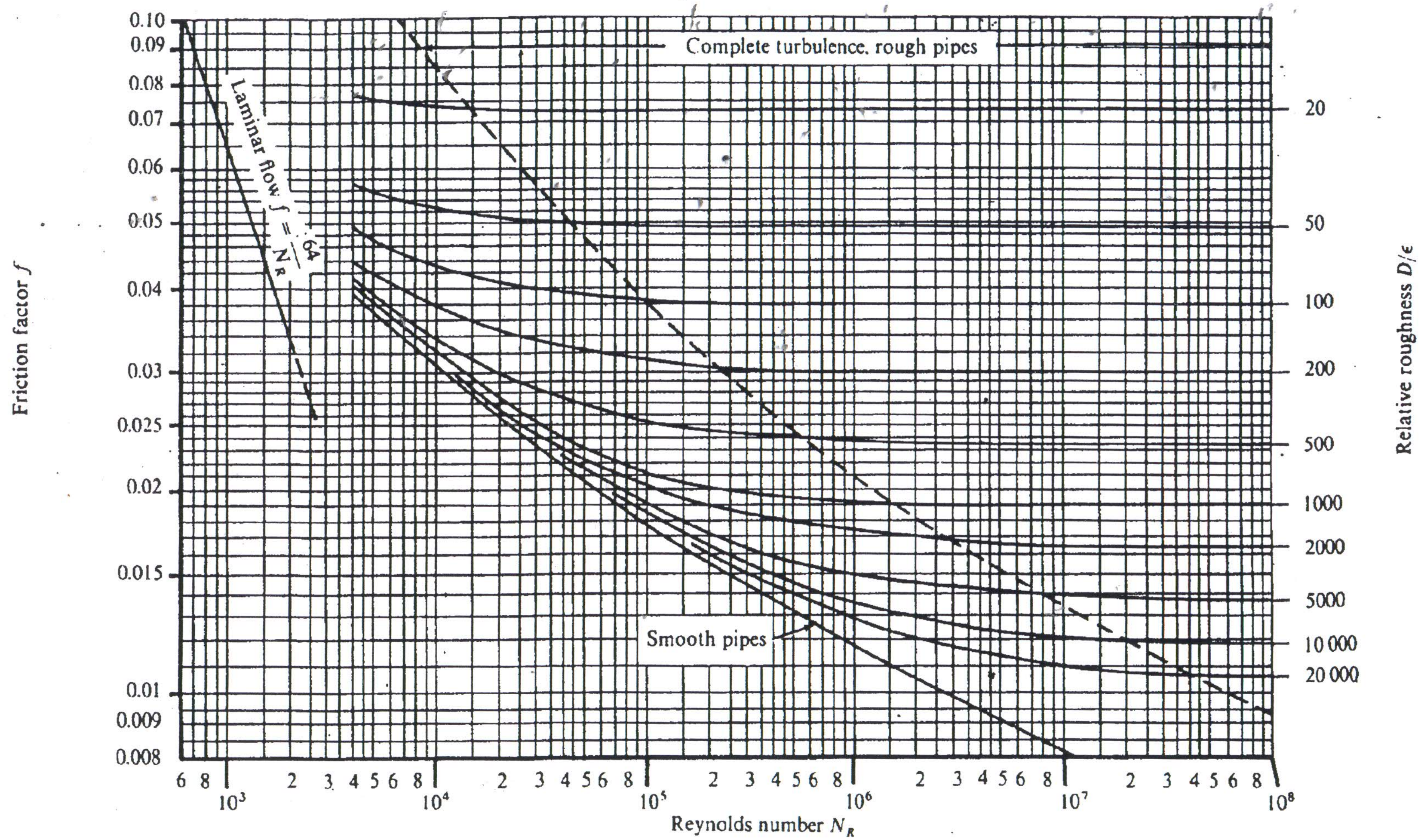

FIGURE 9.2
Moody's diagram. (Source: Pao, R. H. F. 1961. *Fluid Mechanics*. New York: John Wiley & Sons, p. 284)

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/ft³)	Density ρ (slugs/ft³)	Dynamic Viscosity μ (lb-s/ft²)	Kinematic Viscosity ν (ft²/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}

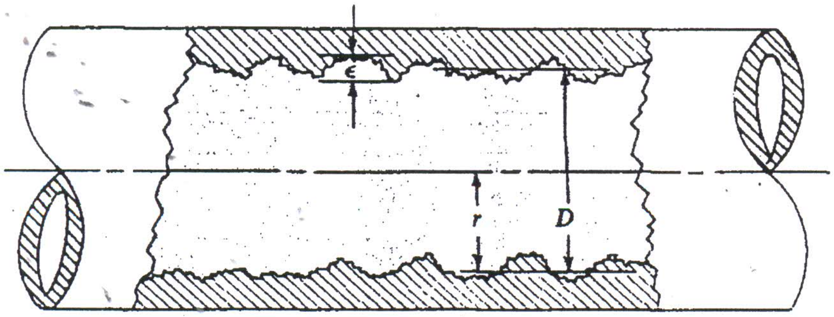

FIGURE 9.1
Pipe wall roughness.

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		Wall Thickness (in)	Flow Area	
		(in)	(ft)		(in^2)	(ft^2)
1/8	0.405	0.269	0.0224	0.068	0.068	0.000394
1/4	0.540	0.364	0.0303	0.088	0.1041	0.000723
3/8	0.675	0.493	0.0411	0.091	0.191	0.00133
1/2	0.840	0.622	0.0518	0.109	0.304	0.00211
3/4	1.050	0.824	0.0687	0.113	0.533	0.0037
1	1.315	1.049	0.0874	0.133	0.864	0.006
1 ,1/4	1.660	1.380	0.1150	0.140	1.496	0.01039
1 ,1/2	1.900	1.610	0.1342	0.145	2.036	0.01414
2	2.375	2.067	0.1723	0.154	3.36	0.02333
2 , 1/2	2.875	2.469	0.2058	0.203	4.79	0.03326
3	3.500	3.068	0.2557	0.216	7.39	0.05132
3 , 1/2	4.000	3.548	0.2957	0.226	9.89	0.06868
4	4.500	4.026	0.3355	0.237	12.73	0.0884
5	5.563	5.047	0.4206	0.258	20.01	0.139
6	6.625	6.065	0.5054	0.280	28.89	0.2006
8	8.625	7.981	0.6651	0.322	50	0.3472
10	10.750	10.020	0.8350	0.365	78.9	0.5479
12	12.750	11.938	0.9948	0.406	111.9	0.7771
14	14.000	13.126	1.0940	0.437	135.3	0.9396
16	16.000	15.000	1.2500	0.500	176.7	1.227
18	18.000	16.876	1.4060	0.562	223.7	1.553
20	20.000	18.814	1.3680	0.593	278	1.931
24	24.000	22.626	1.8860	0.687	402	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:

- 1in= 0.0254m , 1000L=1m^3
- $P_{abs} = P_{atm} + P_{gage}$
- $P = \frac{F}{A}$ where P=Pressure, F=Force, A= C/S Area
- $S.G_s = \frac{\rho_s}{\rho_{water\_@\_4°C}}$ where S.G= spec.Gravity, ρ_s=density substance
- $S.G_s = \frac{\gamma_s}{\gamma_{water\_@\_4°C}}$ 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
- $\text{Re}ynold's\_number: N_R = \frac{vD\rho}{\mu} = \frac{vD}{\upsilon}$
- $h_L = \frac{32\mu L v}{\gamma D_2} = f \times \frac{L}{D} \times \frac{v^2}{2g}$
- $\min or\_loss: h_L = \frac{C_L v_1^2}{2g}$
- $loss\_coefficient: C_L = \left[1 - \left(\frac{A_1}{A_2}\right)^2\right]$