UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Tambahan
Sidang Akademik 1992/93

Jun 1993

IKK 200/4 - PENGANTAR OPERASI PEMINDAHAN

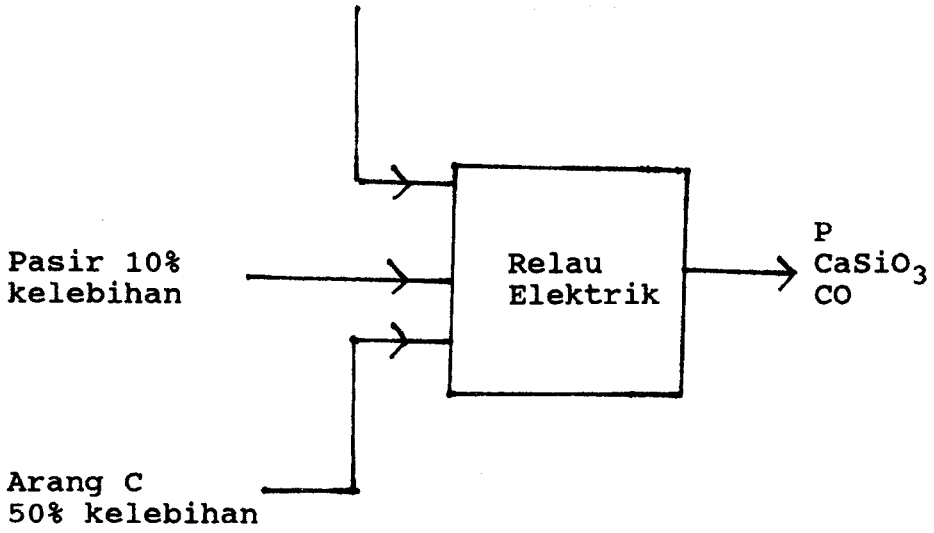
Masa : [3 Jam]

Sila pastikan bahawa kertas soalan ini mengandungi LAPAN (8) mukasurat (termasuk Lampiran) yang bercetak sebelum anda memulakan peperiksaan ini.

Jawab LIMA (5) soalan. Semua soalan mesti dijawab di dalam Bahasa Malaysia.

1. Penghasilan fosforus P

Kalsium fosfat $Ca_3 (PO_4)_2$



Cari a) Peratusan komposisi suap masuk

b) kg fosforus/kg campuran suap

Sekiranya

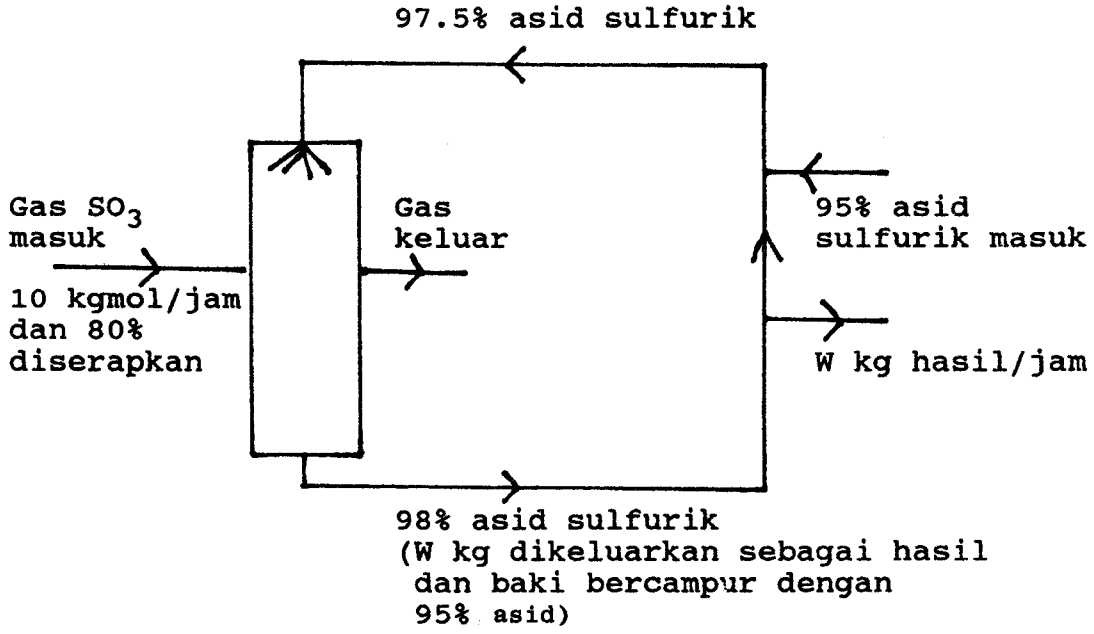
(i) penghuraian fosfat dengan pasir adalah 80% sempurna.

(ii) penurunan oksida fosforus dengan karbon adalah 60% sempurna.

Berat Atom : Ca = 40; P = 31; O = 16; Si = 28; C = 12

(100 markah)

2. Penghasilan H_2SO_4 melalui penyerapan SO_3 oleh asid lemah



Cari nilai W

(100 markah)

3. Untuk penyulingan sesuatu campuran, cari nilai suap masuk, x_f dengan kaedah pengiraan sekiranya

Garis operasi atas y = 0.4x + 0.48

Garis operasi bawah y = 2(x - 0.1)

Nisbah refluks R = 2 kali nilai minimum

Kemeruapan relatif α = 3

(100 markah)

4. Satu rerambut (capillary) kecil bergaris rentas bahagian dalam 2.22×10^{-3} m dan panjangnya 0.317 m digunakan untuk mengukur kadar aliran cecair berketumpatan 875 kg/m^3 dan berkelikatan 1.13×10^{-3} Pa.S. Bacaan kejatuhan tekanan pada rerambut apabila ada aliran ialah 0.0655 m air (ketumpatan air = 996 kg/m^3).

(a) Berapakah kadar aliran dalam m^3/s jika pembetulan kesan penghujung boleh diabaikan.

(30 markah)

(b) Pastikan jenis aliran yang berlaku.

(20 markah)

(c) Untuk suasana dan sistem yang sama tetapi diketahui bahawa halaju aliran ialah 0.275 m/s, berapakah kejatuhan tekanan yang dialami. Diberi bahawa faktor geseran f.

$$f = \frac{16}{N_{Re}}$$

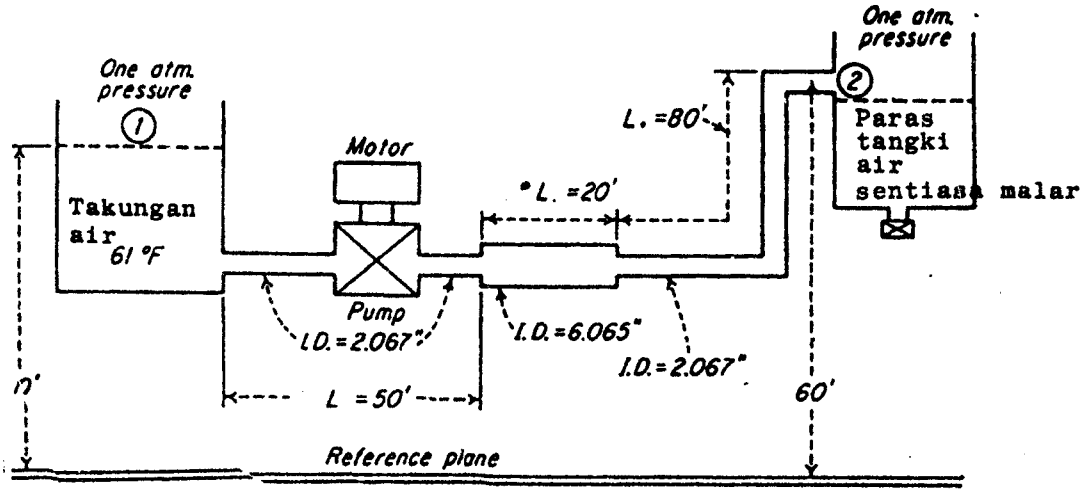
(50 markah)

5. Air pada kadar 300 kg/min memasuki suatu tiub 5.5 cm ID pada suhu 20^{o}C dan dipanaskan hingga 150^{o}C. Suhu dinding tiub ialah 170^{o}C. Dengan menganggapkan bahawa L/D > 50, hitungkan koefisien pemindahan haba individu, dan panjang tiub.

Sifat-sifat air pada 85^{o}C adalah seperti berikut:

ρ	= 0.9686 g/cm^3	c_p	= 1 cal/g-^{o}C
μ	= 0.337 g/m-s	k	= 0.673 W/m-^{o}C
μ_w	= 0.105 g/m-s		

(100 markah)



6. Berapakah kos per jam yang dipertimbangkan untuk pam di dalam gambarajah di atas beroperasi jika kecekapan pam ialah 45 peratus dan kos tenaga elektrik ialah 20 sen per kWhr. Kadar aliran ditetapkan sebanyak 150 gal/min (0.567 m^3/min). Paip diperbuat dari besi keluli komersial (steel).

Diberi

ketumpatan air @ 61°F = 62.3 lb/ft^3

kelikatan air @ 61°F = 1.12 cp

$$= 7.526 \times 10^{-4} \frac{lb}{fts}$$

$$1ft^3 = 7.48 \text{ gal}$$

$$1kw = 738 \frac{ft\ lb_f}{s}$$

(100 markah)

* Boleh dijawab dalam SI atau English units.

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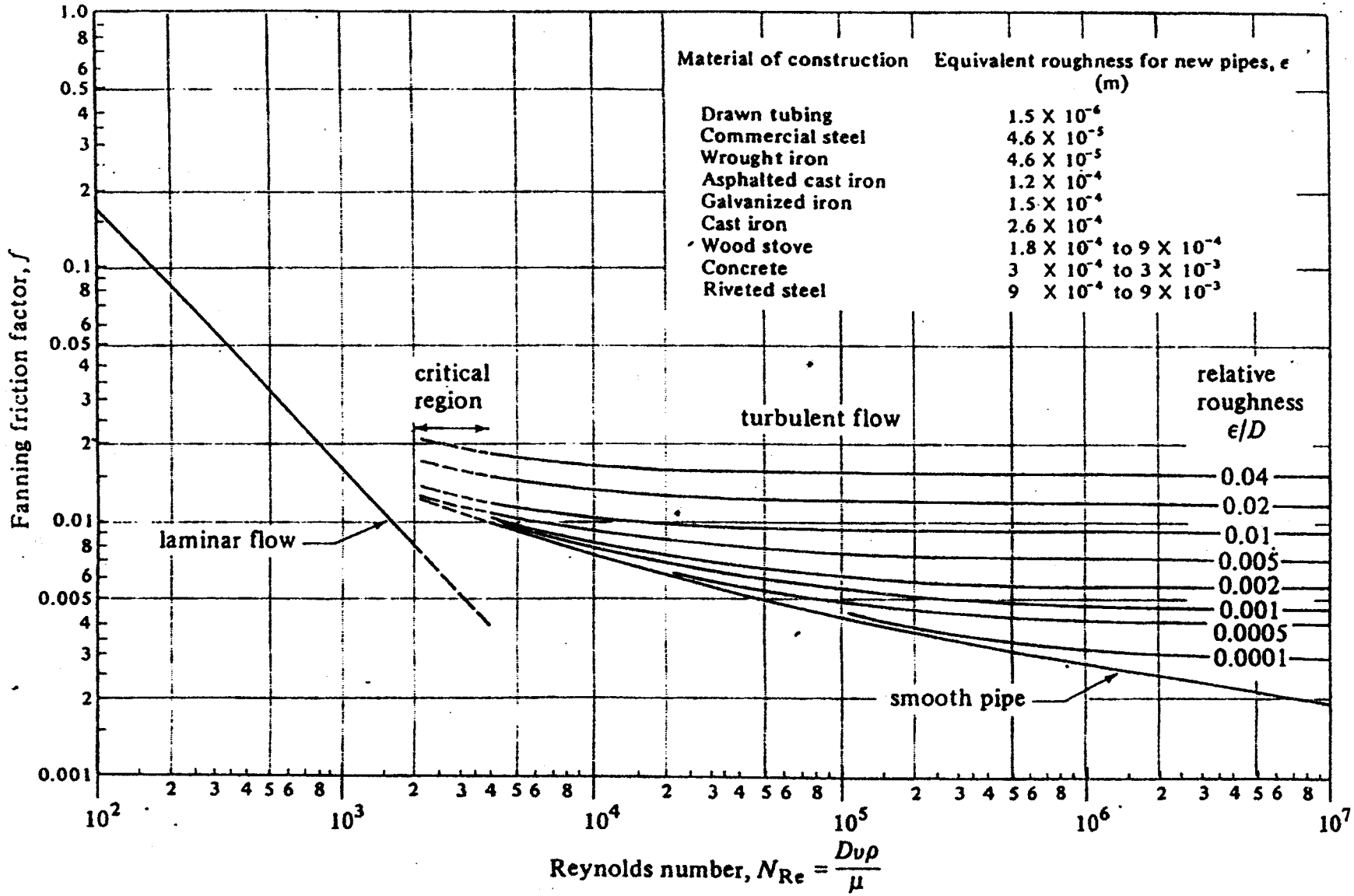

Friction factors for fluids inside pipes. [*Based on L. F. Moody, Trans. A.S.M.E., 66, 671, (1944); Mech. Eng. 69, 1005 (1947). With permission.*]

Friction Loss for Turbulent Flow Through Valves and Fittings

Type of Fitting or Valve	*Frictional Loss, Number of Velocity Heads, K_f*	*Frictional Loss, Equivalent Length of Straight Pipe in Pipe Diameters, L_e/D*
Elbow, 45°	0.35	17
Elbow, 90°	0.75	35
Tee	1	50
Return bend	1.5	75
Coupling	0.04	2
Union	0.04	2
Gate valve		
Wide open	0.17	9
Half open	4.5	225
Globe valve		
Wide open	6.0	300
Half open	9.5	475
Angle valve, wide open	2.0	100
Check valve		
Ball	70.0	3500
Swing	2.0	100
Water meter, disk	7.0	350

Friction Loss for Laminar Flow Through Valves and Fittings (K1)

Type of Fitting or Valve	*Frictional Loss, Number of Velocity Heads, K_f Reynolds Number*					
	50	*100*	*200*	*400*	*1000*	*Turbulent*
Elbow, 90°	17	7	2.5	1.2	0.85	0.75
Tee	9	4.8	3.0	2.0	1.4	1.0
Globe valve	28	22	17	14	10	6.0
Check valve, swing	55	17	9	5.8	3.2	2.0

1 micron = 10^{-6} m = 10^{-4} cm = 10^{-3} mm = 1 μm (micrometer)
1 Å (angstrom) = 10^{-10} m = 10^{-4} μm
1 mile = 5280 ft
1 m = 3.2808 ft = 39.37 in.

A.1-4 Mass

1 lb_m = 453.59 g = 0.45359 kg
1 lb_m = 16 oz = 7000 grains
1 kg = 1000 g = 2.2046 lb_m
1 ton (short) = 2000 lb_m
1 ton (long) = 2240 lb_m
1 ton (metric) = 1000 kg

A.1-5 Standard Acceleration of Gravity

g = 9.80665 m/s^2
g = 980.665 cm/s^2
g = 32.174 ft/s^2
g_c (gravitational conversion factor) = 32.1740 $lb_m \cdot ft/lb_f \cdot s^2$
= 980.665 $g_m \cdot cm/g_f \cdot s^2$

A.1-6 Volume

1 L (liter) = 1000 cm^3
1 in.^{3} = 16.387 cm^3
1 ft^3 = 28.317 L (liter)
1 ft^3 = 0.028317 m^3
1 ft^3 = 7.481 U.S. gal
1 m^3 = 264.17 U.S. gal
1 m^3 = 1000 L (liter)
1 U.S. gal = 4 qt
1 U.S. gal = 3.7854 L (liter)
1 U.S. gal = 3785.4 cm^3
1 British gal = 1.20094 U.S. gal

A.1-7 Force

1 g · cm/s^2 (dyn) = 10^{-5} kg · m/s^2 = 10^{-5} N (newton)
1 g · cm/s^2 = 7.2330 × 10^{-5} $lb_m \cdot ft/s^2$ (poundal)
1 kg · m/s^2 = 1 N (newton)
1 lb_f = 4.4482 N
1 g · cm/s^2 = 2.2481 × 10^{-6} lb_f

A.1-8 Pressure

1 bar = 1 × 10^5 Pa (pascal) = 1 × 10^5 N/m^2
1 psia = 1 lb_f/in.^{2}
1 psia = 2.0360 in. Hg at 0°C
1 psia = 2.311 ft H_2O at 70°F
1 psia = 51.715 mm Hg at 0°C (ρ_{Hg} = 13.5955 g/cm^3)
1 atm = 14.696 psia = 1.01325 × 10^5 N/m^2 = 1.01325 bar
1 atm = 760 mm Hg at 0°C = 1.01325 × 10^5 Pa
1 atm = 29.921 in. Hg at 0°C
1 atm = 33.90 ft H_2O at 4°C

1 psia = 6.89476 × 10^4 g/cm · s^2
1 psia = 6.89476 × 10^4 dyn/cm^2
1 dyn/cm^2 = 2.0886 × 10^{-3} lb_f/ft^2
1 psia = 6.89476 × 10^3 N/m^2
1 lb_f/ft^2 = 4.7880 × 10^2 dyn/cm^2 = 47.880 N/m^2
1 mm Hg (0°C) = 1.333224 × 10^2 N/m^2 = 0.1333224 kPa

A.1-9 Power

1 hp = 0.74570 kW
1 hp = 550 ft · lb_f/s
1 hp = 0.7068 btu/s
1 watt (W) = 14.340 cal/min
1 btu/h = 0.29307 W (watt)
1 J/s (joule/s) = 1 W

A.1-10 Heat, Energy, Work

1 J = 1 N · m = 1 kg · m^2/s^2
1 kg · m^2/s^2 = 1 J (joule) = 10^7 g · cm^2/s^2 (erg)
1 btu = 1055.06 J = 1.05506 kJ
1 btu = 252.16 cal (thermochemical)
1 kcal (thermochemical) = 1000 cal = 4.1840 kJ
1 cal (thermochemical) = 4.1840 J
1 cal (IT) = 4.1868 J
1 btu = 251.996 cal (IT)
1 btu = 778.17 ft · lb_f
1 hp · h = 0.7457 kW · h
1 hp · h = 2544.5 btu
1 ft · lb_f = 1.35582 J
1 ft · lb_f/lb_m = 2.9890 J/kg

A.1-11 Thermal Conductivity

1 btu/h · ft · °F = 4.1365 × 10^{-3} cal/s · cm · °C
1 btu/h · ft · °F = 1.73073 W/m · K

A.1-12 Heat-Transfer Coefficient

1 btu/h · ft^2 · °F = 1.3571 × 10^{-4} cal/s · cm^2 · °C
1 btu/h · ft^2 · °F = 5.6783 × 10^{-4} W/cm^2 · °C
1 btu/h · ft^2 · °F = 5.6783 W/m^2 · K
1 kcal/h · m^2 · °F = 0.2048 btu/h · ft^2 · °F

A.1-13 Viscosity

1 cp = 10^{-2} g/cm · s (poise)
1 cp = 2.4191 lb_m/ft · h
1 cp = 6.7197 × 10^{-4} lb_m/ft · s
1 cp = 10^{-3} Pa · s = 10^{-3} kg/m · s = 10^{-3} N · s/m^2
1 cp = 2.0886 × 10^{-5} $lb_f \cdot s/ft^2$
1 Pa · s = 1 N · s/m^2 = 1 kg/m · s = 1000 cp