LAMPIRAN B

DEKANTER (D-01)

Fungsi : Memisahkan H_2SO_4 dari produk

Bahan konstruksi yang dipilih : *Stainless Steel* AISI (316) (18Cr, 12Ni, 2.5Mo)

Kondisi Operasi :

P = 1 atm = 14,7 psi

T = 55 ^oC = 328,00 K

Asumsi : Linear Alkylbenzene Sulfonate tidak larut

1. NERACA MASSA

Umpan masuk (arus 5) :

komponen	kg/jam	Fraksi berat	BM	Kmol	Fraksi mol	ρ (kg/m^3)	x . ρ	μ (cP)	μ . x
$C_6H_5.C_{12}H_{25}$	107,1055	0,0177	246	0,4354	0,0110	829,7402	14,6584	2,5610	0,0452
$C_{10}H_{21}C_6H_5$	37,4761	0,0062	218	0,1719	0,0044	831,0345	5,1370	1,9055	0,0118
$C_{14}H_{29}C_6H_5$	0,5431	0,0001	274	0,0020	0,0001	834,2542	0,0747	2,9216	0,0003
$C_6H_5.C_{12}H_{25}.SO_3$	3406,4786	0,5619	326	10,4493	0,2651	1058,1676	594,5572	2,1480	1,2069
H_2SO_4	2450,6563	0,4042	98	25,0067	0,6343	1796,0256	725,9863	9,4194	3,8075
H_2O	60,4461	0,0100	18	3,3581	0,0852	999,7097	9,9673	0,5078	0,0051
Total	6062,7057	1,0000		39,4234	1,0000	6348,9319	1350,3809	19,4633	5,0767

ρ campuran = 1350,3809 kg/m^3

μ campuran = 5,0767 cP = 0,0034 lb/ft.s

Fv = 4,4896 m^3/jam = 0,0748 m^3/s

Produk atas (arus 8) :

komponen	kg/jam	Fraksi berat	BM	Kmol	Fraksi mol	ρ (kg/m^3)	x . ρ	μ (cP)	μ . x
$C_6H_5.C_{12}H_{25}$	107,1055	0,0297	246	0,4354	0,0357	829,7402	24,6037	2,5610	0,0759
$C_{10}H_{21}C_6H_5$	37,4761	0,0104	218	0,1719	0,0141	831,0345	8,6222	1,9055	0,0198
$C_{14}H_{29}C_6H_5$	0,5431	0,0002	274	0,0020	0,0002	834,2542	0,1254	2,9216	0,0004
$C_6H_5.C_{12}H_{25}.SO_3$	3406,4786	0,9431	326	10,4493	0,8569	1058,1676	997,9446	2,1480	2,0257
H_2SO_4	49,0131	0,0136	98	0,5001	0,0410	1796,0256	24,3709	9,4194	0,1278
H_2O	11,4330	0,0032	18	0,6352	0,0521	999,7097	3,1643	0,5078	0,0016
Total	3612,0494	1,0000		12,1939	1,0000	6348,9319	1058,8311	19,4633	2,2513

ρ campuran = 1058,8311 kg/m3

μ campuran = 2,2513 cP = 0,0015 lb/ft.s

Fv = 3,4114 m^3/jam = 0,0009 m^3/s

Produk bawah (arus 6) :

Asumsi : Kemurnian H_2SO_4 keluar dekanter adalah 98 % dan Air (H_2O) 2 %

komponen	kg/jam	Fraksi berat	BM	Kmol	Fraksi mol	ρ (kg/m^3)	x . ρ	μ (cP)	μ . x
H_2SO_4	2401,6432	0,9800	98	24,5066	0,9000	1796,0256	1760,1051	9,4194	9,2310
H_2O	49,0131	0,0200	18	2,7230	0,1000	999,7097	19,9942	0,5078	0,0102
Total	2450,6563	1,0000		27,2295	1,0000	2795,7353	1780,0993	9,9272	9,2411

ρ campuran = 1780,0993 kg/m3

μ campuran = 9,2411 cP = 0,0062 lb/ft.s

Fv = 1,3767 m^3/jam = 0,0229 m^3/s

2. Menentukan Fase Terdipersi

Fase ringan

m_1	=	3612,0494	kg/jam
		1,0033	kg/s
ρ_1	=	1058,8311	kg/m^3
		66,0711	lb/ft3
Q_1	=	m / ρ	
	=	3612,0494	kg/jam
		1058,8311	kg/m^3
	=	3,411356	m^3/jam
	=	0,000948	m^3/s
	=	0,0334645	ft3/s
μ_1	=	2,2513	cp
	=	0,0015	lb/ft.s
	=	0,00225	kg/m.s

Fase berat

m_2	=	2450,6563	kg/jam
	=	0,6807	kg/s
ρ_2	=	1780,0993	kg/m^3
	=	111,0782	lb/ft3
Q_2	=	m / ρ	
	=	2450,6563	kg/jam
		1780,0993	kg/m^3
	=	1,376696	m^3/jam
	=	0,000382	m^3/s
	=	0,0135050	ft3/s
μ_2	=	9,2411	cp
	=	0,0062	lb/ft.s
	=	0,00924	kg/m.s

3. Menentukan Dimensi Dekanter

a. Menghitung waktu tinggal dalam dekanter

Dari Coulson,J. M. Hal. 444 waktu tinggal cairan yang baik dalam dekanter berkisar 2-5 menit.

Dirancang t = 5 menit

= 0,0833 jam

b. Menghitung volume decanter

$$V_D = \frac{m_{Feed}.t}{\rho_{Feed}}$$

Vd = $\frac{6062,7057x0,0833}{1350,3809}$

= 0,3741 m^3

= 13,2125 ft^3

Over design = 20%

Volume decanter = 1.2 x 13,2125

= 15,8550 ft^3

Direncanakan dekanter silinder Vertical didesign dengan perbandingan H= 2D

Tutup berbentuk torispherical dished head

Dengan :

V_T = 0.000049. Di3 (Pers. 5.11, Brownell hal 88)

Keterangan :

V_T = volume torispherical head (ft3)

Di = diameter volume tangki

sehingga:

Volume dekanter	=	Vol silinder + Vol tutup
V	=	Vol silinder + 2 Vol Head
V	=	$\frac{1}{4}\pi Di^2 L + [2\{0.000049 .(Di^3)\}]$
15,8550	=	$\frac{1}{4}\pi Di^2 . 2Di + \{(0,000098)Di^3\}$
15,8550	=	$〚Di〛$ ^3{2/4 π+0,000098}
15,8550	=	$〚Di〛$ ^3{2/4 x 3,14+0,000098}
15,8550	=	Di^3x 1,570098
15,8550	=	1,570098 D^3
D^3	=	10,0981
D	=	2,1615 ft
	=	25,9375 in
	=	0,6588 m
H	=	2 D
H	=	4,3229 ft
	=	51,8749 in
	=	1,3176 m

c. Menghitung volume fase ringan

Volume cairan (V1)= $(m1\ x\ t)/\rho 1$

$V_1 = \frac{3612,0494x0,0833}{1058,8311}$

$V_1 = 0,2843\ m^3$

$V_1 = (\pi D\text{^}2)/4\ \text{x}\ H\_(cairan\ 1)$

$0,2843 = (3,14\ x\ (0,6588\ m)\text{^}2)/4\ \text{x}\ H\_(cairan\ 1)$

$0,2843 = 0,34072\ H\_(cairan\ 1)$

$= (0,2843\ m^3) / (0,3407\ m^2)$

$= 0,8344\ m$

d. Menghitung volume fase berat

Volume cairan (V_2)= $(m2\ x\ t)/\rho 2$

$V_2 = \frac{2450,6563x0,0833}{1780,0993}$

$V_2 = 0,1147\ m^3$

$V_2 = (\pi D^2)/4\ \text{x}\ H\_(cairan\ 2) + (0,000049\ \text{x}\ Di^3)$

$0,1147 = (3,14\ x\ (0,6588\ m)^2)/4\ \text{x}\ H\_(cairan\ 2) + (0,000049\ \text{x}\ (0,6588\ m)^3)$

$0,1147 = 0,3407\ H\_(cairan\ 2) + 0,00001401$

$= (0,1147\ m^3) / (0,3407\ m^2)$

$= 0,3368\ m$

5. Menghitung tebal shell (ts)

$$t_S = \frac{P.ri}{f.E - 0.6P} + C$$ (Brownell, 1959. p. 254.,eq 13.1)

Mencari Tekanan hidrostatis :

vol cairan = h cairan x ($\pi D^2/4$)

0,3741 = h cairan x 0,3407

h cairan $= \frac{4,4582}{2,1533}$

h cairan = 1,0981 m

P hidrostatis = ρ.g.hcairan

= 1.058,8311 x 9,8 x 13,1770

= 11.394,3488 N/m^2

= 1,6526 psia

Dimana :

ts = Tebal dinding shell, in

P = Tekanan design = P operasi + P hidrostatis

= 14,7 + 19,8314

= 16,3526 psi

ri = Jari-jari decanter = 12,9687 in

E = Effisiensi sambungan las = 0,85

f =Tekanan maksimal yang diizinkan = 18.847,948 psi

C = Korosi yang diizinkan = 0,125 in

ts = 0,1382 in

jadi, tebal shell minimum yang dibutuhkan adalah = 0,1382 in

maka digunakan ketebalan shell standar = 3/16 in

= 0,1875 in

6. Menentukan tebal head (th)

Direncanakan berbentuk torispherical

OD = ID shell + 2 ts

OD =25,9375 $in + (2\ x\ 0{,}1875)$

= 26,3124674 in

OD standart = 28 in

ID = OD - 2ts

= 27,6250 in

= 0,7017 m

= 2,3021 ft

H = 55,2500 in

= 1,4034 m

= 4,6042 ft

Dari tabel 5-7 Brownell didapatkan data sebagai berikut:

OD : 28 in = 0,7112 m

ts : 0,1875 in

icr : 1 3/4 in

r : 26 in

$$th = \frac{Prw}{(2fE - 0.2P)} + C$$

$$w = \frac{1}{4}\left(3 + \sqrt{\frac{r}{icr}}\right)$$

(Persamaan 7.77 Brownell and Young, 1959 hal :138)

$$w = \left(\frac{1}{4}\right) * \left(3 + \left(\left(\frac{26}{1{,}75}\right)^{\frac{1}{2}}\right)\right)$$

= 1,7136

th = 0,1477 in

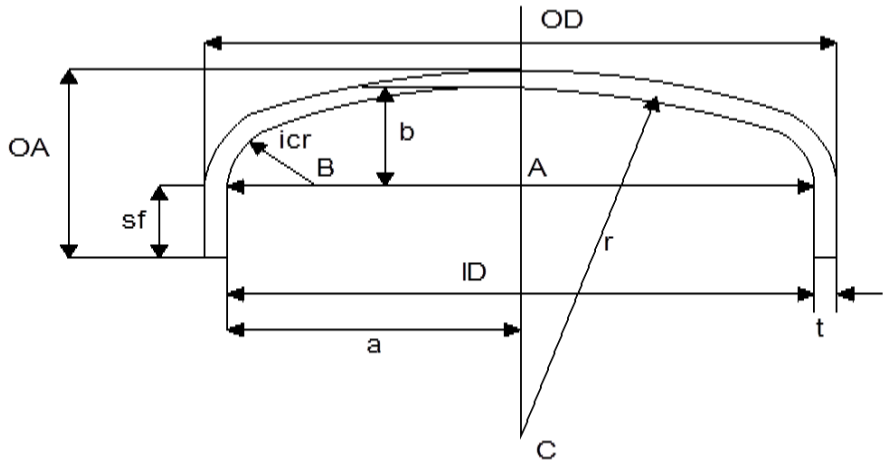
Digunakan tebal standart = 3/16

= 0,1875 in

7. Menghitung tinggi head

nilai sf dengan th 3/16 " adalah 1 1/2 - 2" (tabel 5.4 Brownell)

dipilih nilai sf : 2



$$ID = OD - 2ts$$

ID = 28 in – (2 x 0,1875 in)

= 27,6250 in

$$a = \frac{ID}{2}$$

$$a = \frac{27{,}6250\ in}{2}$$

$$= 13{,}8125 \text{ in}$$

$$AB = a - icr$$

AB = 13,8125 in – 1,75

= 12,0625 in

$$BC = r - icr$$

BC = 26 in – 1,75

= 24,25 in

$$AC = \sqrt{BC^2 - AB^2}$$

$$AC = \sqrt{24{,}25^2 - 12^2}$$

= 21,0371 in

$$b = r - AC$$

b = 26 in – 21,0371 in

= 4,9629 in

h Head = 0,1477 in + 4,9629 in + 2

= 7,1107 in

= 0,180610774 m

8. Merancang pipa

a. Merancang Pipa pemasukan

asumsi : aliran turbulen

qf = 0,001 m^3/s

= 0,0335 ft^3/s

ρ = 84,2638 lb/ft^3

Di_{opt} = 3,9. $Qf^{0,45}$. $\rho^{0,13}$

Di_{opt} = 3,9 x (0,0335 ft^3/s)^{0,45} x (84,2638 lb/ft^3)^{0,13}

Di $_{Opt}$ = 1,5047 in

Diambil pipa standart Tabel 11.Kern, hal: 844

Nominal pipe size = 1 1/2

OD = 1,900 in

ID = 1,610 in

= 0,0409 m

= 0,1342 ft

Schedule Number = 40

Flow area (A) = 2,040 in^2

= 0,0013 m^2

= 0,0142 ft^2

Kecepatan linier

$$(v) = \frac{qf}{A}$$

$$= \frac{0{,}0335\ ft^3/s}{0{,}0142\ ft^2}$$

= 2,3622 ft/s

$$\mathbf{Re} = \frac{ID.\rho.v}{\mu}$$

$$= \frac{0{,}1342\ x\ 84{,}2638\ x\ 2{,}3622}{0{,}0034}$$

= 7827,9498

Karena Re > 2100, maka dipilih aliran turbulen

b. Merancang Pipa Pengeluaran Bottom Product

asumsi : aliran turbulen

qf = 0,00038 m^3/s

= 0,0135 ft^3/s

ρ = 111,0782 lb/ft^3

$Di\ opt$ = 3,9. $Qf^{0,45}$. $\rho^{0,13}$

$Di\ opt$ = 3,9 x (0,0135 ft^3/s)^{0,45} x (111,0782 lb/ft^3)^{0,13}

Di Opt = 1,0369 in

Diambil pipa standart Tabel 11.Kern, hal: 844

Nominal pipe size = 1

OD = 1,320 in

ID = 1,049 in

= 0,0266 m

= 0,0874 ft

Schedule Number = 40

Flow area (A) = 0,864 in^2

= 0,0006 m^2

= 0,0060 ft^2

Kecepatan linier

$$(v) = \frac{qf}{A}$$

$$= \frac{0{,}0135\ ft^3/s}{0{,}0060\ ft^2}$$

= 2,2508 ft/s

$$\mathbf{Re} = \frac{ID.\rho.v}{\mu}$$

$$= \frac{0{,}0874\ x\ 111{,}0782\ x\ 2{,}2508}{0{,}0062}$$

= 3519,4271

Karena Re > 2100, maka dipilih aliran turbulen

c. Merancang Pipa Pengeluaran Top Product

asumsi : aliran turbulen

qf = 0,00095 m^3/s

= 0,0335 ft^3/s

ρ = 66,0711 lb/ft^3

$Di\ opt$ = 3,9. $Qf^{0,45}$. $\rho^{0,13}$

$Di\ opt$ = 3,9 x (0,0335 ft^3/s)^{0,45} x (66,0711 lb/ft^3)^{0,13}

Di Opt = 1,4579 in

Diambil pipa standart Tabel 11.Kern, hal: 844

Nominal pipe size = 1 1/2

OD = 1,900 in

ID = 1,610 in

= 0,0409 m

= 0,1342 ft

Schedule Number = 40

Flow area (A) = 2,040 in^2

= 0,0013 m^2

= 0,0142 ft^2

Kecepatan linier

$$(v) = \frac{qf}{A}$$

$$= \frac{0{,}0335\ ft^3/s}{0{,}0142\ ft^2}$$

= 2,3622 ft/s

$$\mathbf{Re} = \frac{ID.\rho.v}{\mu}$$

$$= \frac{0{,}1342\ x\ 66{,}0711\ x\ 2{,}3622}{0{,}0015}$$

= 13840,9375

Karena Re > 2100, maka dipilih aliran turbulen

9. Menentukan Letak pipa

Menghitung pipa pengeluaran hasil atas (Z1) :

asumsi jarak antara datum dan decanter : 0,6 m

Z1 = 0,6 + H1 + H2

Z1 = 0,6 m + 0,8344 m + 0,3367 m

Z1 = 1,7711 m

Menghitung Tinggi pipa pemasukan (Z3)

Z3 = H2 + 0,6

Z3 = 0,3367 m + 0,6 m

Z3 = 0,9368 m

Menghitung tinggi pipa pengeluaran hasil bawah (Z2)

= 1058,8311 kg/m^3

= 1780,0993 kg/m^3

$$Z_2 = \frac{(Z_1 - Z_3)\rho_1}{\rho_2} + Z_3$$

$$Z2 = \frac{(1{,}7711 - 0{,}9368)x\ 1058{,}8311}{1780{,}0993} + 0{,}9368$$

= 1,4330