LAMPIRAN

Lampiran 1. Perhitungan Dimensi Alat

Perhitungan Perancangan Heat Exchanger

Shell side	Tube side	Temperatur :
IDs = 10 in	IDt = 0,62 in	Th1 = 81 ^{O}C = 177,8 ^{O}F
B = 7	ODt = ¾	Th2 = 77 ^{O}C = 170,6 ^{O}F
Baffle space = 6 in	BWG = 16	Th1 = 4 ^{O}C = 7,2 ^{O}F
Passes = 1	pitch = triangular	Th2 = 25 ^{O}C = 77 ^{O}F
Pt = 0,9375	passes= 2	Tc2 = 33 ^{O}C = 91,4 ^{O}F
C = 0, 99 (fig. 2 Kern)	C = 0,98(fig2 Kern)	ΔTc = 8 ^{O}C = 14,4 ^{O}F
de = 0,045833333 ft	Nt = 12	

Shell

1) Heat Balance:

Q =AU ΔTLMTD

= 232988,87 Btu/jam

A = 7080 cm^2

= 0,708 m^2

= 7,618 ft^2

U = 340btu/jam ft^2 ^{o}F

ΔTLMTD = (Th1-Tc2)-(Th2-Tc1)/(ln(Th1-Tc2)/(Th2-Tc1))

= 89,952 ^{o}F

Q shell = W x C(Th1-Th2)

W shell = Q/C(Th1-Th2)

= 342630,69 / (0,99 x 7,2 ^{o}F)

= 48068,28lb/jam

Q tube = W x C(Th1-Th2)

W tube = Q/C(Th1-Th2)

= 232988,87/ (0,98 x 14,4 ^{o}F)

= 32686,43 lb/jam

2) Δt =

Hot fluid		cold fluid	Diff
177.8	Higher Temp	77	100.8
170.6	Lower Temp	91.4	79.2
7.2	Differences	14.4	21.6

L = 1 m

= 3,2808399ft

= 39,370079 in

LMTD = 89,952 ^{o}F

R = $\frac{7,2}{14,4}$

= 0,5

S = $\frac{14,4}{177,8-91,4}$

= 0,167

Ft = 0,98 (Fig 18 Kern)

Δt = Ft x ΔTLMTD

= 0,98 x 89,952 ^{o}F

= 88,153 ^{o}F

Shell

3) Hot Fluid; shell side, water

= (177,8^{o}F+170,6^{o}F)/2

= 174,2^{o}F

4) As = ID x C'B / 144Pt

dengan C' = Pt – OD

= 0,9375 – ¾

= 0,188 in

B = L/b

$= \frac{39{,}370079\ \text{in}}{6\ in}$

= 7

As = ID x C'B / 144Pt

= 10 in x 0,188 x

(7 / 144) x 0,9375

= 0,091 ft^2

5) Gs = W/as

=2686,43lb/jam/0,09 ft^2

= 358661,651lb/jam ft^2

6) At Ta = (Th1 +Th2) /2

Tube

3) Cold Fluid; tube side, water

4) a't = 0,302 in^2 (table 10 Kern)

at = Ntxa't / 144xn

= 12x(0,302 in^2/144)x 2

= 0,0503 ft^2

5) Gt = w/at

=16509,98lb/jam/

0,0503 ft^2

= 328012,89lb/jamft^2

vel, v = Gt/3600ϱ

= 328012,89lb/jam /

(3600 X62,5)

= 1,458ft/sec

6) At ta = (Tc1+Tc2) / 2

= (77 °F + 91,4 °F) / 2

= 84,2 °F

μ

=((0,95.2,42)+(0,8.2,42))/2

= 0,8712lb/jamft

= 2,118lb/jamft(fig. 14)

μ =((0,35.2,42)+

(0,37.2,42))/2

= 0,8712lb/jamft

Ds = IDs/12

= 10 in / 12

= 0,833 ft

Res = (Ds x Gs) / μ

=(0,833ft x 358661,651

lb/jamft^2)/0,8712

lb/jam ft

=343072,439

(Turbulen)

7) jH = 380 (fig 28 Kern)

8) At Ta = 174,2 ^{o}F

c = 1 Btu/lb °F

k =0.898

Btu/(jam)(ft2)(°F/ft)

(Tabel 4 Kern)

$(c\mu/k)^{(1/3)}$=(0,99x0,8712/

0,898)$^{(1/3)}$

= 0,98664

9) ho = jH x k/de x $(c\mu/k)^{(1/3)}$

=380x0,898Btu/(jam)

(ft^2)(°F)/(0,045833333

ft)x 0,98664)

= 90552,580 Btu/jam

ft^{2o}F

7) D = IDt/12

= 0,62/12

= 0,052 ft

8) Ret = D x Gt/μ

=0,052ftx328012,89

lb/jamft^2/ 2,118lb/jamft

= 8003,4629 (laminar)

9) hi = 415 Btu/jam (ft2) (°F)

(fig 25 kern)

10) hio = hi x ID/OD

= 415 Btu/jam (ft2) (°F)

x (0,62 in / ¾)

= 343,067

13) Clean overall (Uc) = hio x ho/hio + ho

= (343,067 x 90552,580) / (343,067 + 90552,580)

= 341,772 Btu/(jam)(ft^2)(°F)

14) Rd = Uc-UD / UcxUD

= (341,772– 340) / (341,772x 340)

= 0,00002 (hr))(ft^2)(°F) / Btu

Summary

90552,580	h outside	343,067
Uc	341,772	
U_D	340	
Rd Calculated	0.00002	
Rd Required	0.001	

Pressure Drop

Shell

1) Res = 343072,4395

f = 0.001ft/in^2

2) No. of crosses, N + 1 = 12L/B

= 12 x 6,56167979

= 78,74

Ds = 10/12

= 0,833 ft

3) ΔPs = (f x Gs^2 x Ds x (N+1)) / (5,22 x 10^{10} x Ds x Ǿs)

= ((0,001 x $(358661,651)^2$ x 0,833 x 78,74)) / (5,22 x 10^{10} x 0,833 x 1)

= 0,194 psi

Tube

1) Ret = 8003,462882

= 0,00015 ft^2 / in^2

2) ΔPt = (f x Gt^2 x L x n) / (5,22 x 10^{10} x Ds x Øt)

= ((0,00015 x $(328012,89)^2$ x 1 x 2) / (5,22 x 10^{10} x 0,052 x 1)

= 0,012 psi

3) Gt = 328012,89lb/jamft^2

$V^2/2G'$ = 0,03

4) ΔPr = 4 n/s ($v^2/2G'$)

= 4 x (2/1) x 0,03

= 0,24 psi

ΔPT = ΔPt + ΔPr

= 0,012+ 0,24

= 0,252 psi

Lampiran 2. Perhitungan Pengujian Alat

$\Delta T_{LMTD} = \frac{(Th1-Tc2)-(Th2-Tc1)}{Ln(\frac{Th1-Tc2}{Th2-Tc1})}$

1) $\Delta T_{LMTD} = \frac{(55-45)-(46-28)}{Ln(\frac{55-45}{46-28})}$ = 13,6104°C = 56,4987°F

2) $\Delta T_{LMTD} = \frac{(50-42)-(43-28)}{Ln(\frac{50-42}{43-28})}$ = 11,1357°C = 52,0443°F

3) $\Delta T_{LMTD} = \frac{(45-39)-(40-28)}{Ln(\frac{45-39}{40-28})}$ = 8,6562°C = 47,5811°F

4) $\Delta T_{LMTD} = \frac{(35-32)-(33-28)}{Ln(\frac{35-32}{33-28})}$ = 3,9152°C = 39,0474°F

$Q = A\ U\ \Delta T_{LMTD}$

1) Q = 7,618ft^2 x 340 Btu/jam ft^{2o}F x 56,4987°F = 146338,3724 Btu/jam
2) Q = 7,618ft^2 x 340 Btu/jam ft^{2o}F x 52,0443°F = 134800,8976 Btu/jam
3) Q = 7,618ft^2 x 340 Btu/jam ft^{2o}F x 47,5811°F = 123240,7754 Btu/jam
4) Q = 7,618ft^2 x 340 Btu/jam ft^{2o}F x 39,0474°F = 101137,4897 Btu/jam