AZAS TEKNIK KIMIA II

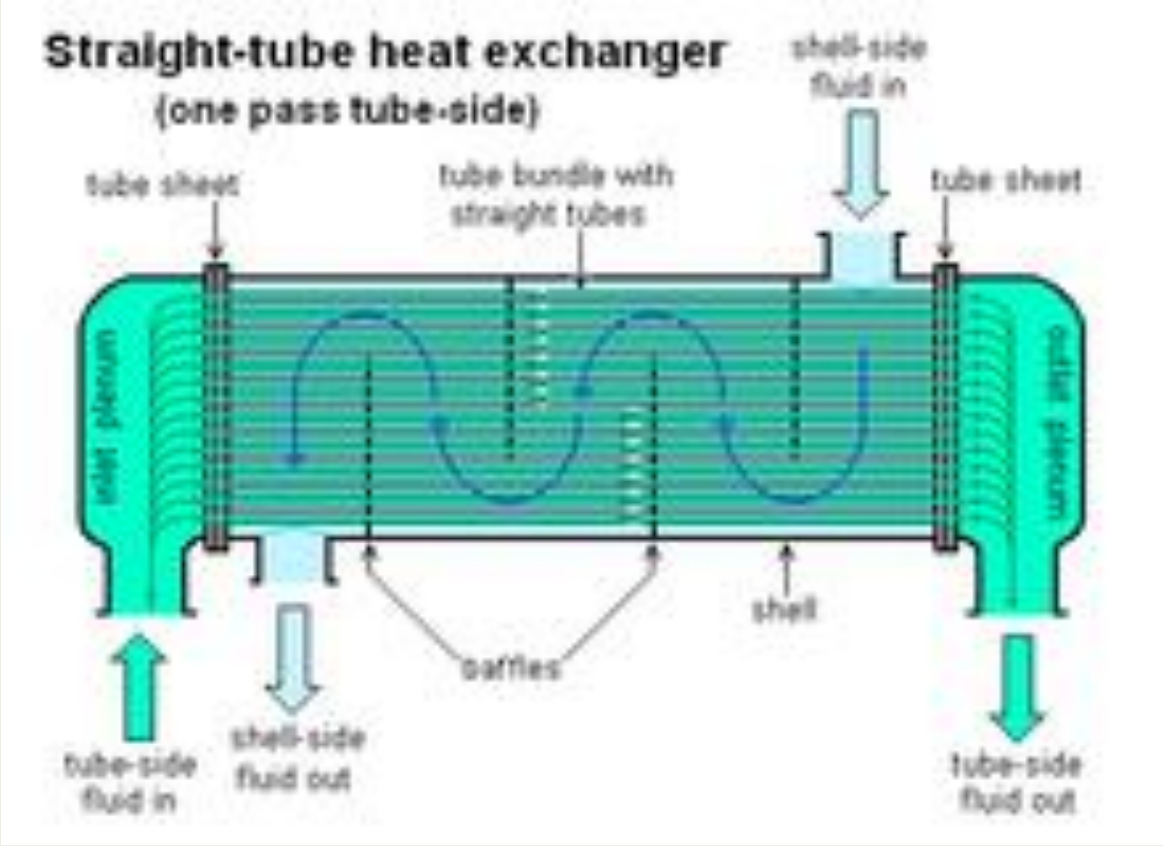
PERTEMUAN KE ENAM
TENTANG HEATER USING STEAM

DODY GUNTAMA, S.T., M.Eng

Heat Exchanger

- Heat Exchanger atau sering kita sebut **Alat Penukar Panas** merupakan alat yang berfungsi untuk memindahkan energi panas antara dua atau lebih fluida dan terjadi pada temperatur yang berbeda antara fluida, dimana fluida tersebut ada yang bertindak sebagai fluida panas (hot fluid) dan yang lain bertindak sebagai fluida dingin (cold fluid).

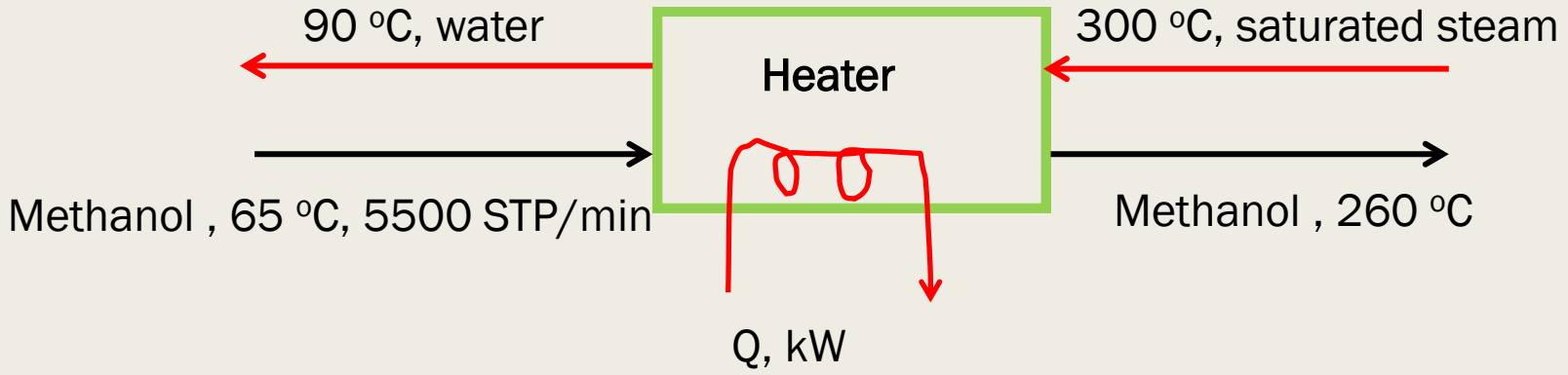
Heat Exchanger



Problem: Heater using steam

Saturated steam at 300 °C is used to heat a countercurrently flowing stream of methanol vapor from 65 °C to 260 °C in an adiabatic heat exchanger. The flow rate of the methanol is 5500 standard liters per minute, and the steam condenses and leaves the heat exchanger as liquid water at 90 °C.

- Calculate the required flow rate of the entering steam in m^3/min.
- Calculate the rate of heat transfer from the steam to the methanol (kW).



Cara Pengerjaan

1. Cari data CP untuk methanol di buku felder

Senyawa	n (mol)	a	b	c	d
Metanol (v)	245,54	0,04293	0,00008301	-1,87E-08	-8,03E-12

2. Konversi flow rate yang ada

mol=	5500	liter (stp)	1	mol	=	245,5357143	mol
		min	22,4	liter (stp)			Min

Lanjutan

3. Hitung Q untuk methanol

$$Q = n\int_{65}^{260} Cp_{methanol}(v).dT$$

$$= n_{metanol}\int_{65}^{260} cp.dT_{metanol}$$

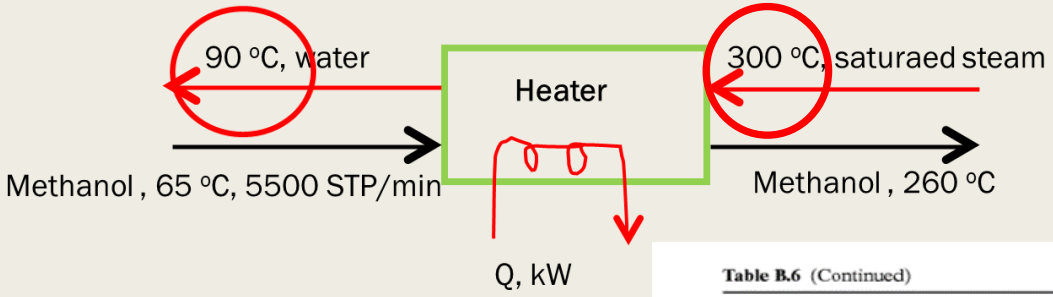
$$= 245{,}536[(42{,}93x10^{-3})(260-65) + \frac{8{,}302x10^{-5}}{2}(260^2-65^2)$$

$$+ \frac{-1{,}87x10^{-8}}{3}(260^3-65^3) + \frac{-8{,}03x10^{-12}}{4}(260^4-65^4)]$$

$$Q = 2672{,}594 kJ/\min = 44{,}543\,\mathrm{kW}$$

Lanjutan

4. Setelah itu karena heater ini menggunakan pemanas yang berasal dari steam, yang mana steam yang digunakan adalah steam dengan kondisi suhu masuk dengan suhu 300 °Celcius dan suhu water keluar di set 90 °celcius.



Sehingga kita bisa mencari entalpi untuk steam, di table steam di buku felder TABEL B,6, Sehingga didapat :

Senyawa	Steam 300 C	Water 90 C
H, kJ/kg	2750,90	376,8

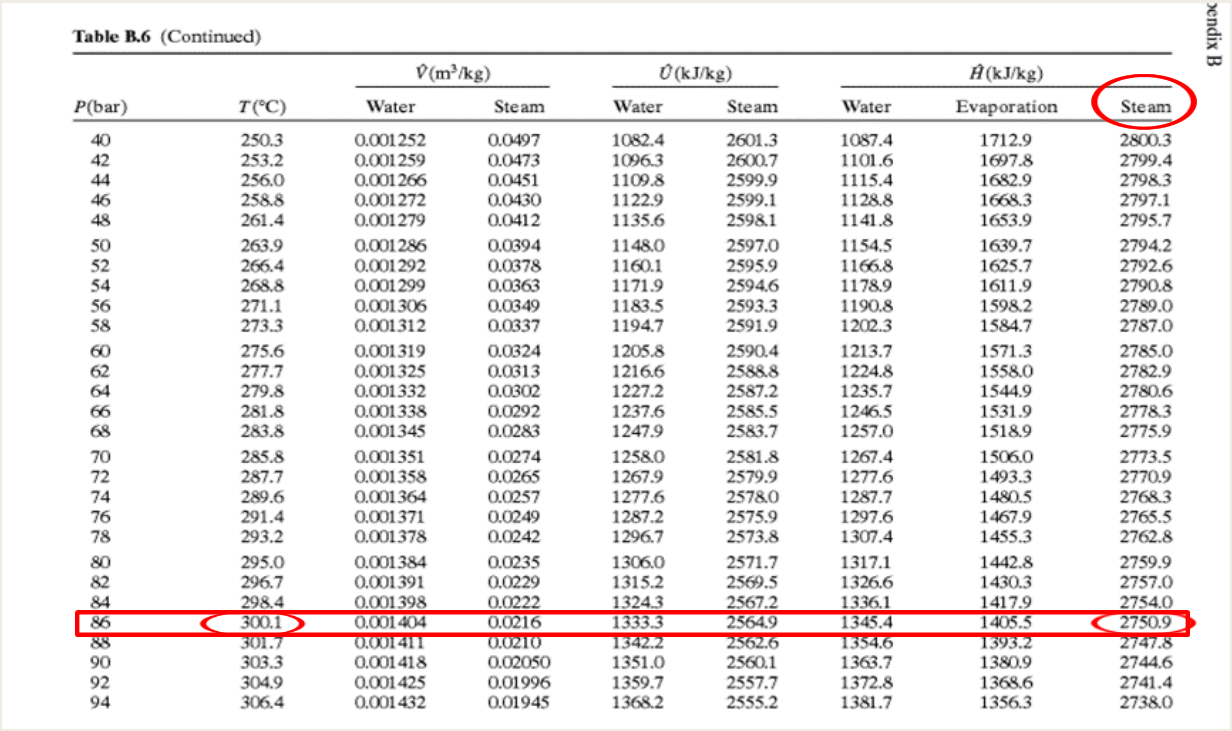


Table B.6 (Continued)

		$\hat{V}$(m³/kg)		$\hat{U}$(kJ/kg)		$\hat{H}$(kJ/kg)		
P(bar)	T(°C)	Water	Steam	Water	Steam	Water	Evaporation	Steam
40	250.3	0.001252	0.0497	1082.4	2601.3	1087.4	1712.9	2800.3
42	253.2	0.001259	0.0473	1096.3	2600.7	1101.6	1697.8	2799.4
44	256.0	0.001266	0.0451	1109.8	2599.9	1115.4	1682.9	2798.3
46	258.8	0.001272	0.0430	1122.9	2599.1	1128.8	1668.3	2797.1
48	261.4	0.001279	0.0412	1135.6	2598.1	1141.8	1653.9	2795.7
50	263.9	0.001286	0.0394	1148.0	2597.0	1154.5	1639.7	2794.2
52	266.4	0.001292	0.0378	1160.1	2595.9	1166.8	1625.7	2792.6
54	268.8	0.001299	0.0363	1171.9	2594.6	1178.9	1611.9	2790.8
56	271.1	0.001306	0.0349	1183.5	2593.3	1190.8	1598.2	2789.0
58	273.3	0.001312	0.0337	1194.7	2591.9	1202.3	1584.7	2787.0
60	275.6	0.001319	0.0324	1205.8	2590.4	1213.7	1571.3	2785.0
62	277.7	0.001325	0.0313	1216.6	2588.8	1224.8	1558.0	2782.9
64	279.8	0.001332	0.0302	1227.2	2587.2	1235.7	1544.9	2780.6
66	281.8	0.001338	0.0292	1237.6	2585.5	1246.5	1531.9	2778.3
68	283.8	0.001345	0.0283	1247.9	2583.7	1257.0	1518.9	2775.9
70	285.8	0.001351	0.0274	1258.0	2581.8	1267.4	1506.0	2773.5
72	287.7	0.001358	0.0265	1267.9	2579.9	1277.6	1493.3	2770.9
74	289.6	0.001364	0.0257	1277.6	2578.0	1287.7	1480.5	2768.3
76	291.4	0.001371	0.0249	1287.2	2575.9	1297.6	1467.9	2765.5
78	293.2	0.001378	0.0242	1296.7	2573.8	1307.4	1455.3	2762.8
80	295.0	0.001384	0.0235	1306.0	2571.7	1317.1	1442.8	2759.9
82	296.7	0.001391	0.0229	1315.2	2569.5	1326.6	1430.3	2757.0
84	298.4	0.001398	0.0222	1324.3	2567.2	1336.1	1417.9	2754.0
86	300.1	0.001404	0.0216	1333.3	2564.9	1345.4	1405.5	2750.9
88	301.7	0.001411	0.0210	1342.2	2562.6	1354.6	1393.2	2747.8
90	303.3	0.001418	0.02050	1351.0	2560.1	1363.7	1380.9	2744.6
92	304.9	0.001425	0.01996	1359.7	2557.7	1372.8	1368.6	2741.4
94	306.4	0.001432	0.01945	1368.2	2555.2	1381.7	1356.3	2738.0

LANJUTAN

Table B.6 (Continued)

P(bar)	T(°C)	$\hat{V}$(m³/kg) Water	$\hat{V}$(m³/kg) Steam	$\hat{U}$(kJ/kg) Water	$\hat{U}$(kJ/kg) Steam	$\hat{H}$(kJ/kg) Water	$\hat{H}$(kJ/kg) Evaporation	$\hat{H}$(kJ/kg) Steam
0.15	54.0	0.001014	10.02	226.0	2448.9	226.0	2373.2	2599.2
0.16	55.3	0.001015	9.43	231.6	2450.6	231.6	2370.0	2601.6
0.17	56.6	0.001015	8.91	236.9	2452.3	236.9	2366.9	2603.8
0.18	57.8	0.001016	8.45	242.0	2453.9	242.0	2363.9	2605.9
0.19	59.0	0.001017	8.03	246.8	2455.4	246.8	2361.1	2607.9
0.20	60.1	0.001017	7.65	251.5	2456.9	251.5	2358.4	2609.9
0.22	62.2	0.001018	7.00	260.1	2459.6	260.1	2353.3	2613.5
0.24	64.1	0.001019	6.45	268.2	2462.1	268.2	2348.6	2616.8
0.26	65.9	0.001020	5.98	275.6	2464.4	275.7	2344.2	2619.9
0.28	67.5	0.001021	5.58	282.7	2466.5	282.7	2340.0	2622.7
0.30	69.1	0.001022	5.23	289.3	2468.6	289.3	2336.1	2625.4
0.35	72.7	0.001025	4.53	304.3	2473.1	304.3	2327.2	2631.5
0.40	75.9	0.001027	3.99	317.6	2477.1	317.7	2319.2	2636.9
0.45	78.7	0.001028	3.58	329.6	2480.7	329.6	2312.0	2641.7
0.50	81.3	0.001030	3.24	340.5	2484.0	340.6	2305.4	2646.0
0.55	83.7	0.001032	2.96	350.6	2486.9	350.6	2299.3	2649.9
0.60	86.0	0.001033	2.73	359.9	2489.7	359.9	2293.6	2653.6
0.65	88.0	0.001035	2.53	368.5	2492.2	368.6	2288.3	2656.9
0.70	90.0	0.001036	2.36	376.7	2494.5	376.8	2283.3	2660.1
0.75	91.8	0.001037	2.22	384.4	2496.7	384.5	2278.6	2663.0
0.80	93.5	0.001039	2.087	391.6	2498.8	391.7	2274.1	2665.8
0.85	95.2	0.001040	1.972	398.5	2500.8	398.6	2269.8	2668.4
0.90	96.7	0.001041	1.869	405.1	2502.6	405.2	2265.6	2670.9
0.95	98.2	0.001042	1.777	411.4	2504.4	411.5	2261.7	2673.2
1.00	99.6	0.001043	1.694	417.4	2506.1	417.5	2257.9	2675.4
1.01325 (1 atm)	100.0	0.001044	1.673	419.0	2506.5	419.1	2256.9	2676.0

[a]From R. W. Haywood, *Thermodynamic Tables in SI (Metric) Units*, Cambridge University Press, London, 1968. $\hat{V}$ = specific volume, $\hat{U}$ = specific internal energy, and $\hat{H}$ = specific enthalpy. *Note:* kJ/kg × 0.4303 = Btu/lb$_m$.

(*continued*)

Senyawa	Steam 300 C	Water 90 C
H, kJ/kg	2750,90	376,8

LANJUTAN

5. Setelah itu kita mencari nilai rho untuk steam pada suhu 300° celcius

$$\rho = \frac{1}{\tilde{V}}\ \text{kg}/m^3$$

$$= \frac{1}{0{,}0216}$$

$$= 46{,}296\ \text{kg}/m^3$$

Table B.6 (Continued)

		$\hat{V}$(m³/kg)		$\hat{U}$(kJ/kg)		$\hat{H}$(kJ/kg)		
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94	306.4	0.001432	0.01945	1368.2	2555.2	1381.7	1356.3	2738.0

Lanjutan

6. Setelah itu kita menghitung massa steam :

$$\text{m}assa\ steam = \frac{Q}{(\hat{\text{H}}steam, 300°C - \hat{\text{H}}air, 90°C)}$$

$$\text{m}assa\ steam = \frac{2672{,}5939\ kj/min}{(2750{,}90\,\frac{Kj}{Kg} - 376{,}8\,\frac{Kj}{Kg})}$$

$$= 1{,}1257\ kg/menit$$

7. Setelah itu mencari volume steam

$$Volume\ steam = \frac{massa\ steam}{\rho\ steam}$$

$$= \frac{1{,}1257\ kg/menit}{46{,}296\ kg/m^3} = 0{,}0243 m^3/menit$$

Penyelesaian Menggunakan Excel:

volume gas metanol = 5500 liter stp

Senyawa	n (mol)	a	b	c	d
Metanol (v)	245,54	0,04293	0,00008301	-1,87E-08	-8,03E-12

T1 = 65 °C

T2 = 260 °C

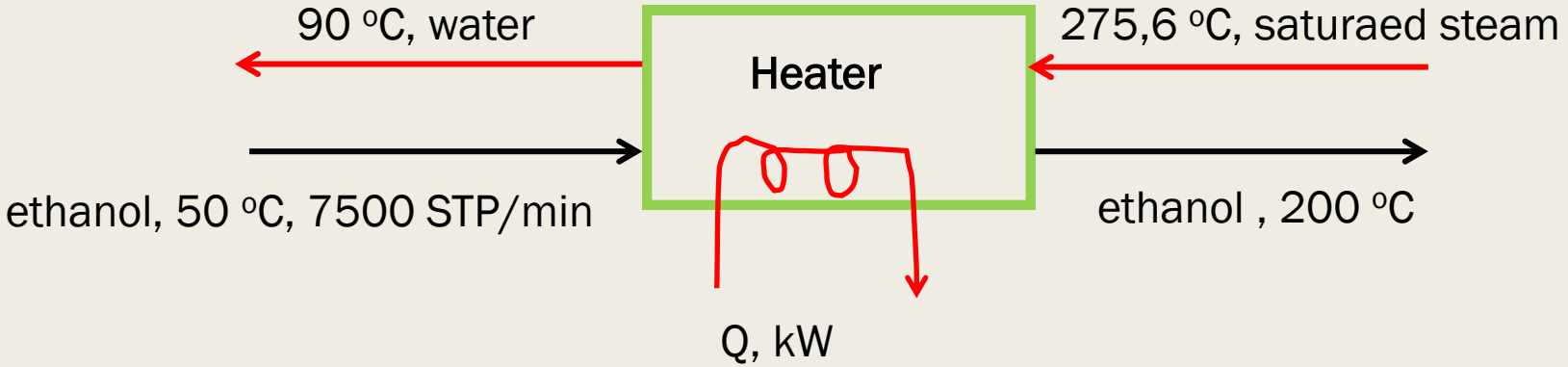
Senyawa	Q = m.cp dT (kJ)	
Metanol (v)	2672,593928	
Q =	2672,593928	kJ/min
	44,54323213	Kw

Senyawa	Steam 300 C	Water 90 C	
H, kJ/kg	2750,90	376,8	
ρ = kg/m3	46,296		
m, steam =	1,125729299		kg/menit
V, steam =	0,024315753		m3/menit

KERJAKAN SOAL LATIHAN YA !!!!

Saturated steam at 275,6 ^{o}C is used to heat a countercurrently flowing stream of ethanol vapor from 50 ^{o}C to 200 ^{o}C in an adiabatic heat exchanger. The flow rate of the Ethanol is 7500 standard liters per minute, and the steam condenses and leaves the heat exchanger as liquid water at 90 ^{o}C.

- Calculate the required flow rate of the entering steam in m^3/min.
- Calculate the rate of heat transfer from the steam to the ethanol (kW).



Senyawa	n (mol)	a	b	c	d
Etanol (v)	334,82	0,06134	0,0001572	-8,749E-08	1,983E-11

JAWABANNYA BERAPA ????
KERJAKAN AGAR BISA LEBIH PAHAM YA !!!

TERIMAKASIH