國立臺灣海洋大學一００學年度研究所碩士班暨碩士在職專班入學考試試題

考試科目： 單元操作

系所名稱： 食品科學系碩士班食工組

※可使用計算器

1.答案以橫式由左至右書寫。2.請依題號順序作答。

1. (20%) 濕紙漿含水 60 wt%，將其乾燥除去原始總含水量 40%之水分，請問經過乾燥後的紙漿其成分(含水 wt%)如何?若有 1000kg/min 之餵料，乾燥後之產品流量若干(kg/min)?
2. (20%) 使用所附的蒸汽表計算一磅水經過下列過程的焓值(enthalpy)變化: (a) 在 30 psia 下，將液體水由 40°F 加熱到 240°F (b) 將液體水由 40°F 加熱到 240°F 後，在 240°F, 24.97 psia 下蒸發成水蒸汽。
3. (20%) 單效蒸發系統中，2 wt%的稀薄鹽溶液以每小時 4500 kg 流量餵料，濃縮成 3 wt%之產品，請問蒸發器頂端蒸氣流量若干(kg/hr)? 3wt%之濃鹽溶液產量若干(kg/hr)?
4. (20%) 何謂絕熱飽和(adiabatic saturation, 又稱絕熱濕化，adiabatic humidification)? 溫室水牆為將空氣吹過向下滴落的水流，使氣、液兩相經過充分接觸後離開，請猜猜水牆的作用為何?為何有此作用?
5. (20%) 請舉出兩種測量液體流量的裝置(中、英文名稱皆可)並簡述其原理。

Temperature		c_p		Temperature		c_p	
°F	K	$btu/lb_m \cdot °F$	$kJ/kg \cdot K$	°F	K	$btu/lb_m \cdot °F$	$kJ/kg \cdot K$
32	273.15	0.500	2.093	−10	249.85	0.461	1.930
20	266.45	0.490	2.052	−20	244.25	0.452	1.892
10	260.95	0.481	2.014	−30	238.75	0.442	1.850
0	255.35	0.472	1.976	−40	233.15	0.433	1.813

Source: Adapted from ASHRAE, *Handbook of Fundamentals*, New York: ASHRAE, 1972.

A.2-9 Properties of Saturated Steam and Water (Steam Table), SI Units

Temperature (°C)	Vapor Pressure (kPa)	Specific Volume (m^3/kg)		Enthalpy (kJ/kg)		Entropy ($kJ/kg \cdot K$)	
		Liquid	Sat'd Vapor	Liquid	Sat'd Vapor	Liquid	Sat'd Vapor
0.01	0.6113	0.0010002	206.136	0.00	2501.4	0.0000	9.1562
3	0.7577	0.0010001	168.132	12.57	2506.9	0.0457	9.0773
6	0.9349	0.0010001	137.734	25.20	2512.4	0.0912	9.0003
9	1.1477	0.0010003	113.386	37.80	2517.9	0.1362	8.9253
12	1.4022	0.0010005	93.784	50.41	2523.4	0.1806	8.8524
15	1.7051	0.0010009	77.926	62.99	2528.9	0.2245	8.7814
18	2.0640	0.0010014	65.038	75.58	2534.4	0.2679	8.7123
21	2.487	0.0010020	54.514	88.14	2539.9	0.3109	8.6450
24	2.985	0.0010027	45.883	100.70	2545.4	0.3534	8.5794
25	3.169	0.0010029	43.360	104.89	2547.2	0.3674	8.5580
27	3.567	0.0010035	38.774	113.25	2550.8	0.3954	8.5156
30	4.246	0.0010043	32.894	125.79	2556.3	0.4369	8.4533
33	5.034	0.0010053	28.011	138.33	2561.7	0.4781	8.3927
36	5.947	0.0010063	23.940	150.86	2567.1	0.5188	8.3336
40	7.384	0.0010078	19.523	167.57	2574.3	0.5725	8.2570
45	9.593	0.0010099	15.258	188.45	2583.2	0.6387	8.1648
50	12.349	0.0010121	12.032	209.33	2592.1	0.7038	8.0763
55	15.758	0.0010146	9.568	230.23	2600.9	0.7679	7.9913
60	19.940	0.0010172	7.671	251.13	2609.6	0.8312	7.9096
65	25.03	0.0010199	6.197	272.06	2618.3	0.8935	7.8310
70	31.19	0.0010228	5.042	292.98	2626.8	0.9549	7.7553
75	38.58	0.0010259	4.131	313.93	2635.3	1.0155	7.6824
80	47.39	0.0010291	3.407	334.91	2643.7	1.0753	7.6122
85	57.83	0.0010325	2.828	355.90	2651.9	1.1343	7.5445
90	70.14	0.0010360	2.361	376.92	2660.1	1.1925	7.4791
95	84.55	0.0010397	1.9819	397.96	2668.1	1.2500	7.4159
100	101.35	0.0010435	1.6729	419.04	2676.1	1.3069	7.3549

Temperature (°C)	Vapor Pressure (kPa)	Specific Volume (m^3/kg)		Enthalpy (kJ/kg)		Entropy ($kJ/kg \cdot K$)	
		Liquid	Sat'd Vapor	Liquid	Sat'd Vapor	Liquid	Sat'd Vapor
105	120.82	0.0010475	1.4194	440.15	2683.8	1.3630	7.2958
110	143.27	0.0010516	1.2102	461.30	2691.5	1.4185	7.2387
115	169.06	0.0010559	1.0366	482.48	2699.0	1.4734	7.1833
120	198.53	0.0010603	0.8919	503.71	2706.3	1.5276	7.1296
125	232.1	0.0010649	0.7706	524.99	2713.5	1.5813	7.0775
130	270.1	0.0010697	0.6685	546.31	2720.5	1.6344	7.0269
135	313.0	0.0010746	0.5822	567.69	2727.3	1.6870	6.9777
140	316.3	0.0010797	0.5089	589.13	2733.9	1.7391	6.9299
145	415.4	0.0010850	0.4463	610.63	2740.3	1.7907	6.8833
150	475.8	0.0010905	0.3928	632.20	2746.5	1.8418	6.8379
155	543.1	0.0010961	0.3468	653.84	2752.4	1.8925	6.7935
160	617.8	0.0011020	0.3071	675.55	2758.1	1.9427	6.7502
165	700.5	0.0011080	0.2727	697.34	2763.5	1.9925	6.7078
170	791.7	0.0011143	0.2428	719.21	2768.7	2.0419	6.6663
175	892.0	0.0011207	0.2168	741.17	2773.6	2.0909	6.6256
180	1002.1	0.0011274	0.19405	763.22	2778.2	2.1396	6.5857
190	1254.4	0.0011414	0.15654	807.62	2786.4	2.2359	6.5079
200	1553.8	0.0011565	0.12736	852.45	2793.2	2.3309	6.4323
225	2548	0.0011992	0.07849	966.78	2803.3	2.5639	6.2503
250	3973	0.0012512	0.05013	1085.36	2801.5	2.7927	6.0730
275	5942	0.0013168	0.03279	1210.07	2785.0	3.0208	5.8938
300	8581	0.0010436	0.02167	1344.0	2749.0	3.2534	5.7045

Source: Abridged from J. H. Keenan, F. G. Keyes, P. G. Hill, and J. G. Moore, *Steam Tables—Metric Units*, New York: John Wiley & Sons, Inc., 1969. Reprinted by permission of John Wiley & Sons, Inc.

A.2-9 Properties of Saturated Steam and Water (Steam Table), English Units

Temperature (°F)	Vapor Pressure (psia)	Specific Volume (ft^3/lb_m)		Enthalpy (btu/lb_m)		Entropy ($btu/lb_m \cdot °F$)	
		Liquid	Sat'd Vapor	Liquid	Sat'd Vapor	Liquid	Sat'd Vapor
32.02	0.08866	0.016022	3302	0.00	1075.4	0.000	2.1869
35	0.09992	0.016021	2948	3.00	1076.7	0.00607	2.1764
40	0.12166	0.016020	2445	8.02	1078.9	0.01617	2.1592
45	0.14748	0.016021	2037	13.04	1081.1	0.02618	2.1423
50	0.17803	0.016024	1704.2	18.06	1083.3	0.03607	2.1259
55	0.2140	0.016029	1431.4	23.07	1085.5	0.04586	2.1099
60	0.2563	0.016035	1206.9	28.08	1087.7	0.05555	2.0943
65	0.3057	0.016042	1021.5	33.09	1089.9	0.06514	2.0791

A.2-9 English Units, *Continued*

Temperature (°F)	Vapor Pressure (psia)	Specific Volume (ft^3/lb_m)		Enthalpy (btu/lb_m)		Entropy ($btu/lb_m \cdot °F$)	
		Liquid	Sat'd Vapor	Liquid	Sat'd Vapor	Liquid	Sat'd Vapor
70	0.3622	0.016051	867.7	38.09	1092.0	0.07463	2.0642
75	0.4300	0.016061	739.7	43.09	1094.2	0.08402	2.0497
80	0.5073	0.016073	632.8	48.09	1096.4	0.09332	2.0356
85	0.5964	0.016085	543.1	53.08	1098.6	0.10252	2.0218
90	0.6988	0.016099	467.7	58.07	1100.7	0.11165	2.0083
95	0.8162	0.016114	404.0	63.06	1102.9	0.12068	1.9951
100	0.9503	0.016130	350.0	68.05	1105.0	0.12963	1.9822
110	1.2763	0.016166	265.1	78.02	1109.3	0.14730	1.9574
120	1.6945	0.016205	203.0	88.00	1113.5	0.16465	1.9336
130	2.225	0.016247	157.17	97.98	1117.8	0.18172	1.9109
140	2.892	0.016293	122.88	107.96	1121.9	0.19851	1.8892
150	3.722	0.016343	96.99	117.96	1126.1	0.21503	1.8684
160	4.745	0.016395	77.23	127.96	1130.1	0.23130	1.8484
170	5.996	0.016450	62.02	137.97	1134.2	0.24732	1.8293
180	7.515	0.016509	50.20	147.99	1138.2	0.26311	1.8109
190	9.343	0.016570	40.95	158.03	1142.1	0.27866	1.7932
200	11.529	0.016634	33.63	168.07	1145.9	0.29400	1.7762
210	14.125	0.016702	27.82	178.14	1149.7	0.30913	1.7599
212	14.698	0.016716	26.80	180.16	1150.5	0.31213	1.7567
220	17.188	0.016772	23.15	188.22	1153.5	0.32406	1.7441
230	20.78	0.016845	19.386	198.32	1157.1	0.33880	1.7289
240	24.97	0.016922	16.327	208.44	1160.7	0.35335	1.7143
250	29.82	0.017001	13.826	218.59	1164.2	0.36772	1.7001
260	35.42	0.017084	11.768	228.76	1167.6	0.38193	1.6864
270	41.85	0.017170	10.066	238.95	1170.9	0.39597	1.6731
280	49.18	0.017259	8.650	249.18	1174.1	0.40986	1.6602
290	57.53	0.017352	7.467	259.44	1177.2	0.42360	1.6477
300	66.98	0.017448	6.472	269.73	1180.2	0.43720	1.6356
310	77.64	0.017548	5.632	280.06	1183.0	0.45067	1.6238
320	89.60	0.017652	4.919	290.43	1185.8	0.46400	1.6123
330	103.00	0.017760	4.312	300.84	1188.4	0.47722	1.6010
340	117.93	0.017872	3.792	311.30	1190.8	0.49031	1.5901
350	134.53	0.017988	3.346	321.80	1193.1	0.50329	1.5793
360	152.92	0.018108	2.961	332.35	1195.2	0.51617	1.5688
370	173.23	0.018233	2.628	342.96	1197.2	0.52894	1.5585
380	195.60	0.018363	2.339	353.62	1199.0	0.54163	1.5483
390	220.2	0.018498	2.087	364.34	1200.6	0.55422	1.5383
400	247.1	0.018638	1.8661	375.12	1202.0	0.56672	1.5284
410	276.5	0.018784	1.6726	385.97	1203.1	0.57916	1.5187
450	422.1	0.019433	1.1011	430.2	1205.6	0.6282	1.4806

Source: Abridged from J. H. Keenan, F. G. Keyes, P. G. Hill, and J. G. Moore, *Steam Tables—English Units.* New York: John Wiley & Sons, Inc., 1969. Reprinted by permission of John Wiley & Sons, Inc.

A.2-10 Properties of Superheated Steam (Steam Table), SI Units (v, specif m^3/kg; H, enthalpy, kJ/kg; s, entropy, kJ/kg · K)

Absolute Pressure, kPa (Sat. Temp., °C)		Temperature (°C)						
		100	150	200	250	300	360	
	v	17.196	19.512	21.825	24.136	26.445	29.216	3
10	H	2687.5	2783.0	2879.5	2977.3	3076.5	3197.6	3
(45.81)	s	8.4479	8.6882	8.9038	9.1002	9.2813	9.4821	9
	v	3.418	3.889	4.356	4.820	5.284	5.839	
50	H	2682.5	2780.1	2877.7	2976.0	3075.5	3196.8	3
(81.33)	s	7.6947	7.9401	8.1580	8.3556	8.5373	8.7385	8
	v	2.270	2.587	2.900	3.211	3.520	3.891	
75	H	2679.4	2778.2	2876.5	2975.2	3074.9	3196.4	3
(91.78)	s	7.5009	7.7496	7.9690	8.1673	8.3493	8.5508	8
	v	1.6958	1.9364	2.172	2.406	2.639	2.917	
100	H	2672.2	2776.4	2875.3	2974.3	3074.3	3195.9	3
(99.63)	s	7.3614	7.6134	7.8343	8.0333	8.2158	8.4175	8
	v		1.2853	1.4443	1.6012	1.7570	1.9432	
150	H		2772.6	2872.9	2972.7	3073.1	3195.0	3
(111.37)	s		7.4193	7.6433	7.8438	8.0720	8.2293	8
	v		0.4708	0.5342	0.5951	0.6548	0.7257	0
400	H		2752.8	2860.5	2964.2	3066.8	3190.3	3
(143.63)	s		6.9299	7.1706	7.3789	7.5662	7.7712	7
	v			0.2999	0.3363	0.3714	0.4126	0
700	H			2844.8	2953.6	3059.1	3184.7	3
(164.97)	s			6.8865	7.1053	7.2979	7.5063	7
	v			0.2060	0.2327	0.2579	0.2873	0
1000	H			2827.9	2942.6	3051.2	3178.9	3
(179.91)	s			6.6940	6.9247	7.1229	7.3349	7
	v			0.13248	0.15195	0.16966	0.18988	0
1500	H			2796.8	2923.3	3037.6	3.1692	3
(198.32)	s			6.4546	6.7090	6.9179	7.1363	7
	v				0.11144	0.12547	0.14113	0.
2000	H				2902.5	3023.5	3159.3	3
(212.42)	s				6.5453	6.7664	6.9917	7
	v				0.08700	0.09890	0.11186	0.
2500	H				2880.1	3008.8	3149.1	3
(223.99)	s				6.4085	6.6438	6.8767	7
	v				0.07058	0.08114	0.09233	0.
3000	H				2855.8	2993.5	3138.7	3
(233.90)	s				6.2872	6.5390	6.7801	6

Source: Abridged from J. H. Keenan, F. G. Keyes, P. G. Hill, and J. G. Moore, *Steam Tables—Metric Units.* New Yo Inc., 1969. Reprinted by permission of John Wiley & Sons, Inc.