College of Engineering
Mechanical Engineering Department

Second Stage

THERMODYNAMIC I

CHAPTER THREE – THE WORKING FLUID

PREPARED BY
DR. MAHMOOD SHAKER

Lecture no. 1 – How to use steam tables

Case #1 : Saturated Steam :

Required One main property like pressure or temperature with steam saturated condition (Dry) :

Example 1 : Find u,h, and v for saturated steam at a pressure of 10 bar ?

Solution :

Ask ? What the type of the steam ?

Look to (Saturated) which mean the steam is Dry and the Dryness fraction is 1 , therefore the following can apply :

u=ug , h=hg , and v= vg at steam pressure 10 bar

Lecture no. 1 – How to use steam tables-Cont.

Solution :

v=0.1943 m3/kg

u=2581.9 kJ/kg

h=2776.2 kJ/kg

p	t	v_f	v_g	u_f	u_g	h_f	h_{fg}	h_g	s_f	s_g	p	
0.75	167.8	0.001112	0.2554	708.5	2573.3	709.3	2055.5	2764.8	2.020	6.682	0.75	
0.80	170.4	0.001115	0.2403	720.0	2575.3	720.9	2046.5	2767.5	2.046	6.660	0.80	
0.85	172.9	0.001118	0.2268	731.1	2577.1	732.0	2037.9	2769.9	2.071	6.639	0.85	
0.90	175.4	0.001121	0.2148	741.6	2578.8	742.6	2029.5	2772.1	2.094	6.619	0.90	
0.95	177.7	0.001124	0.2040	751.8	2580.4	752.8	2021.4	2774.2	2.117	6.601	0.95	
1.00	179.9	0.001127	0.1943	761.5	2581.9	762.6	2013.6	2776.2	2.138	6.583	1.00	10 bar
1.05	182.0	0.001130	0.1855	770.8	2583.3	772.0	2005.9	2778.0	2.159	6.566	1.05	
1.10	184.1	0.001133	0.1774	779.9	2584.5	781.1	1998.5	2779.7	2.179	6.550	1.10	
1.15	186.0	0.001136	0.1700	788.6	2585.8	789.9	1991.3	2781.3	2.198	6.534	1.15	
1.20	188.0	0.001139	0.1632	797.1	2586.9	798.4	1984.3	2782.7	2.216	6.519	1.20	
1.25	189.8	0.001141	0.1569	805.3	2588.0	806.7	1977.4	2784.1	2.234	6.505	1.25	
1.30	191.6	0.001144	0.1511	813.2	2589.0	814.7	1970.7	2785.4	2.251	6.491	1.30	
1.4	195.0	0.001149	0.1407	828.5	2590.8	830.1	1957.7	2787.8	2.284	6.465	1.4	
1.5	198.3	0.001154	0.1317	842.9	2592.4	844.7	1945.2	2789.9	2.314	6.441	1.5	
1.6	201.4	0.001159	0.1237	856.7	2593.8	858.6	1933.2	2791.7	2.344	6.418	1.6	
1.7	204.3	0.001163	0.1166	869.9	2595.1	871.8	1921.5	2793.4	2.371	6.396	1.7	
1.8	207.1	0.001168	0.1103	882.5	2596.3	884.6	1910.3	2794.8	2.398	6.375	1.8	
1.9	209.8	0.001172	0.1047	894.6	2597.3	896.8	1899.3	2796.1	2.423	6.355	1.9	
2.0	212.4	0.001177	0.0995	906.2	2598.2	908.6	1888.6	2797.2	2.447	6.337	2.0	20 bar
2.1	214.9	0.001181	0.0949	917.5	2598.9	920.0	1878.2	2798.2	2.470	6.319	2.1	
2.2	217.2	0.001185	0.0907	928.3	2599.6	931.0	1868.1	2799.1	2.492	6.301	2.2	
2.3	219.6	0.001189	0.0868	938.9	2600.2	941.6	1858.2	2799.8	2.514	6.285	2.3	
2.4	221.8	0.001193	0.0832	949.1	2600.7	951.9	1848.5	2800.4	2.534	6.269	2.4	
2.5	223.9	0.001197	0.0799	959.0	2601.2	962.0	1839.0	2800.9	2.554	6.254	2.5	
2.6	226.0	0.001201	0.0769	968.6	2601.5	971.7	1829.6	2801.4	2.574	6.239	2.6	
2.7	228.1	0.001205	0.0740	978.0	2601.8	981.2	1820.5	2801.7	2.592	6.224	2.7	
2.8	230.0	0.001209	0.0714	987.1	2602.1	990.5	1811.5	2802.0	2.611	6.210	2.8	
2.9	232.0	0.001213	0.0689	996.0	2602.3	999.5	1802.6	2802.2	2.628	6.197	2.9	
3.0	233.8	0.001216	0.0666	1004.7	2602.4	1008.4	1793.9	2802.3	2.646	6.184	3.0	30 bar

Pressure in MN/m²

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LOOK TABLE 8 PAGE 13 !

Lecture no. 1 – How to use steam tables-Cont.

Case #2 : Wet Steam :

Required two main properties like : pressure and temperature or pressure with dryness fraction

Example 2 : Find u,h, and v for wet steam at 10 bar with dryness fraction (x=0.85) ?

Solution :

Ask ? What type of the steam ?

Look to (wet) which mean the steam is wet and the Dryness fraction is less than 1 , therefore the following can apply :

$$u=u_f+x(u_g-u_f) \ ,$$

$$h=h_f+xh_{fg} \text{ or } h=h_f+x(h_g-h_f)$$

$$\text{and } v= xv_g$$

Lecture no. 1 – How to use steam tables-Cont.

p	t	v_f	v_g	u_f	u_g	h_f	h_{fg}	h_g	s_f	s_g	p	
0.75	167.8	0.001112	0.2554	708.5	2573.3	709.3	2055.5	2764.8	2.020	6.682	0.75	
0.80	170.4	0.001115	0.2403	720.0	2575.3	720.9	2046.5	2767.5	2.046	6.660	0.80	
0.85	172.9	0.001118	0.2268	731.1	2577.1	732.0	2037.9	2769.9	2.071	6.639	0.85	
0.90	175.4	0.001121	0.2148	741.6	2578.8	742.6	2029.5	2772.1	2.094	6.619	0.90	
0.95	177.7	0.001124	0.2040	751.8	2580.4	752.8	2021.4	2774.2	2.117	6.601	0.95	
1.00	179.9	0.001127	0.1943	761.5	2581.9	762.6	2013.6	2776.2	2.138	6.583	1.00	10 bar
1.05	182.0	0.001130	0.1855	770.8	2583.3	772.0	2005.9	2778.0	2.159	6.566	1.05	
1.10	184.1	0.001133	0.1774	779.9	2584.5	781.1	1998.5	2779.7	2.179	6.550	1.10	
1.15	186.0	0.001136	0.1700	788.6	2585.8	789.9	1991.3	2781.3	2.198	6.534	1.15	
1.20	188.0	0.001139	0.1632	797.1	2586.9	798.4	1984.3	2782.7	2.216	6.519	1.20	
1.25	189.8	0.001141	0.1569	805.3	2588.0	806.7	1977.4	2784.1	2.234	6.505	1.25	
1.30	191.6	0.001144	0.1511	813.2	2589.0	814.7	1970.7	2785.4	2.251	6.491	1.30	
1.4	195.0	0.001149	0.1407	828.5	2590.8	830.1	1957.7	2787.8	2.284	6.465	1.4	
1.5	198.3	0.001154	0.1317	842.9	2592.4	844.7	1945.2	2789.9	2.314	6.441	1.5	
1.6	201.4	0.001159	0.1237	856.7	2593.8	858.6	1933.2	2791.7	2.344	6.418	1.6	
1.7	204.3	0.001163	0.1166	869.9	2595.1	871.8	1921.5	2793.4	2.371	6.396	1.7	
1.8	207.1	0.001168	0.1103	882.5	2596.3	884.6	1910.3	2794.8	2.398	6.375	1.8	
1.9	209.8	0.001172	0.1047	894.6	2597.3	896.8	1899.3	2796.1	2.423	6.355	1.9	
2.0	212.4	0.001177	0.0995	906.2	2598.2	908.6	1888.6	2797.2	2.447	6.337	2.0	20 bar
2.1	214.9	0.001181	0.0949	917.5	2598.9	920.0	1878.2	2798.2	2.470	6.319	2.1	
2.2	217.2	0.001185	0.0907	928.3	2599.6	931.0	1868.1	2799.1	2.492	6.301	2.2	
2.3	219.6	0.001189	0.0868	938.9	2600.2	941.6	1858.2	2799.8	2.514	6.285	2.3	
2.4	221.8	0.001193	0.0832	949.1	2600.7	951.9	1848.5	2800.4	2.534	6.269	2.4	
2.5	223.9	0.001197	0.0799	959.0	2601.2	962.0	1839.0	2800.9	2.554	6.254	2.5	
2.6	226.0	0.001201	0.0769	968.6	2601.5	971.7	1829.6	2801.4	2.574	6.239	2.6	
2.7	228.1	0.001205	0.0740	978.0	2601.8	981.2	1820.5	2801.7	2.592	6.224	2.7	
2.8	230.0	0.001209	0.0714	987.1	2602.1	990.5	1811.5	2802.0	2.611	6.210	2.8	
2.9	232.0	0.001213	0.0689	996.0	2602.3	999.5	1802.6	2802.2	2.628	6.197	2.9	
3.0	233.8	0.001216	0.0666	1004.7	2602.4	1008.4	1793.9	2802.3	2.646	6.184	3.0	30 bar

Pressure in MN/m²

13

LOOK TABLE 8 PAGE 13 !

Solution :

v=0.85*0.1943
=0.1651 m3/kg

u=761.5+0.85(2581.9-761.5)
= 2308.84 kJ/kg

h=762.6+0.85*2013.6
= 2474.16 kJ/kg

Lecture no. 1 – How to use steam tables-Cont.

Case #3 : Superheated Steam :

Required two main properties like pressure and temperature

Example 3 : Find u,h, and v for steam at a pressure of 10 bar and a temperature of 200°C?

Solution :

Ask ? What type of the steam ? Here we need to make simple check :

Go to table 8 , page 13 , and look to the temperature at a pressure of 10 bar?

CHECK : $t_{sat.}$ **= 179.9°C (Saturation temperature)**

The given t = 200 °C which is greater than $t_{sat.}$ ($t > t_{sat.}$) ,

The steam is Superheated

Lecturer no. 1 – How to use steam tables-Cont.

Solution :

To find enthalpy , h
use table 9 page 16

h= 2827 kJ/kg

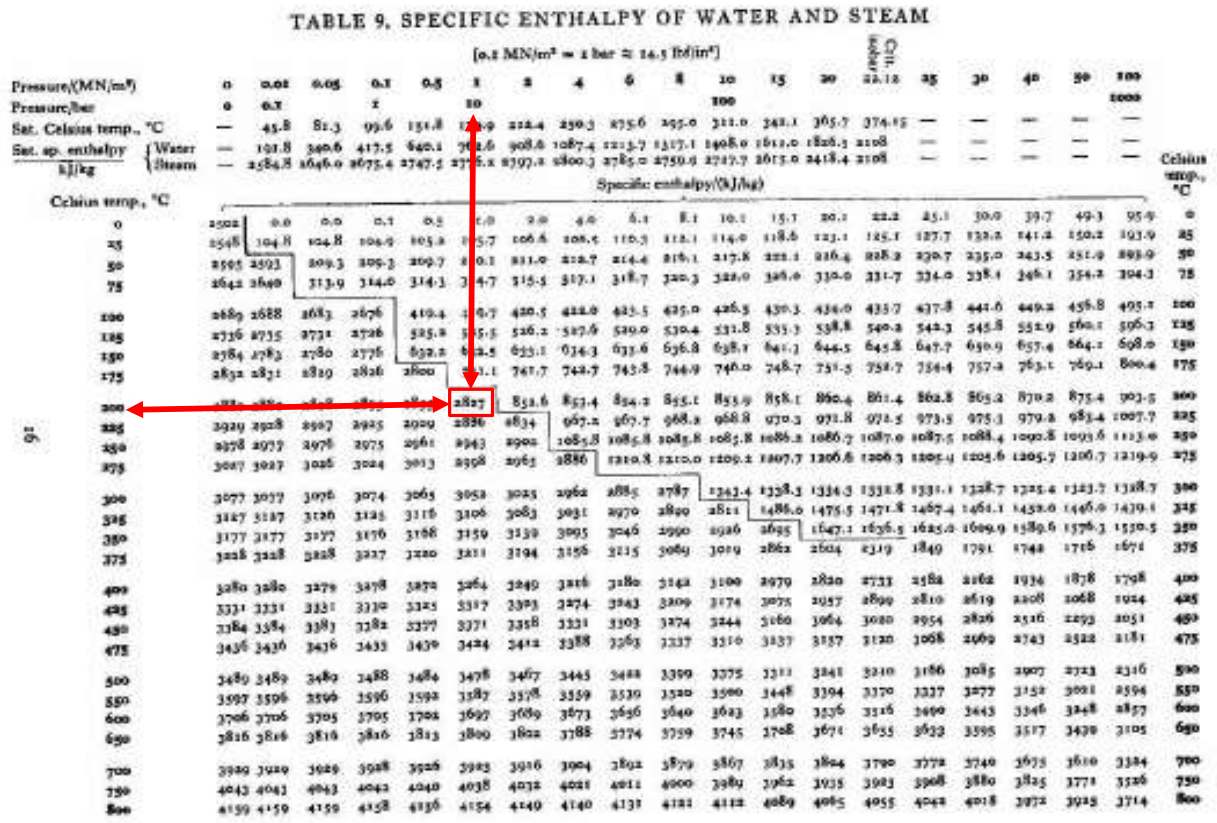

TABLE 9. SPECIFIC ENTHALPY OF WATER AND STEAM

[0.1 MN/m² = 1 bar ≈ 14.5 lbf/in²]

Pressure/(MN/m²)	0	0.01	0.05	0.1	0.5	1	2	4	6	8	10	15	20	22.12 (critical)	25	30	40	50	100	
Pressure/bar	0	0.1		1		10					100								1000	
Sat. Celsius temp., °C	—	45.8	81.3	99.6	151.8	179.9	212.4	250.3	275.6	295.0	311.0	342.1	365.7	374.15	—	—	—	—	—	
Sat. sp. enthalpy kJ/kg (Water)	—	191.8	340.6	417.5	640.1	762.6	908.6	1087.4	1213.7	1317.1	1408.0	1611.0	1826.3	2108	—	—	—	—	—	
kJ/kg (Steam)	—	2584.8	2646.0	2675.4	2747.5	2775.2	2797.2	2800.3	2785.0	2750.6	2727.7	2615.0	2418.4	2108	—	—	—	—	—	

Specific enthalpy/(kJ/kg)

Celsius temp., °C																				Celsius temp., °C
0	2502	0.0	0.0	0.1	0.5	1.0	2.0	4.0	5.1	8.1	10.1	15.1	20.1	22.2	25.1	30.0	39.7	49.3	95.9	0
25	2548	104.8	104.8	104.9	105.2	105.7	106.6	108.5	110.3	113.1	114.9	118.6	123.1	125.1	127.7	132.2	141.8	150.2	193.9	25
50	2595	2593	209.3	209.3	209.7	210.1	211.0	212.7	214.4	216.1	217.8	221.1	226.4	228.2	230.7	235.0	243.5	251.9	293.9	50
75	2642	2640	313.9	314.0	314.3	314.7	315.5	317.1	318.7	320.3	322.0	326.0	330.0	331.7	334.0	338.1	346.1	354.2	394.3	75
100	2689	2688	2683	2676	419.4	419.7	420.5	422.0	423.5	425.0	426.5	430.3	434.0	435.7	437.8	441.6	449.2	456.8	495.1	100
125	2736	2735	2731	2726	525.2	525.5	526.2	527.6	529.0	530.4	531.8	535.3	538.8	540.2	542.3	545.8	552.9	560.1	596.3	125
150	2784	2783	2780	2776	632.2	632.5	633.1	634.3	635.6	636.8	638.1	641.3	644.5	645.8	647.7	650.9	657.4	664.1	698.0	150
175	2832	2831	2829	2826	2800	740.1	741.7	742.7	743.8	744.9	746.0	748.7	751.5	752.7	754.4	757.2	763.1	769.1	800.4	175
200						2827	852.6	853.4	854.2	855.1	855.9	858.1	860.4	861.4	862.8	865.2	870.2	875.4	903.5	200
225	2929	2928	2927	2925	2909	2896	2834	967.2	967.7	968.2	968.8	970.3	971.8	972.5	973.5	975.3	979.2	983.4	1007.7	225
250	2978	2977	2976	2975	2961	2943	2901	1085.8	1085.8	1085.8	1085.8	1086.2	1086.7	1087.0	1087.5	1088.4	1090.8	1093.6	1113.0	250
275	3027	3027	3026	3024	3013	2998	2963	2886	1210.8	1210.0	1209.2	1207.7	1206.6	1206.3	1205.4	1205.6	1205.7	1206.7	1219.9	275
300	3077	3077	3076	3074	3065	3052	3025	2962	2885	2787	1343.4	1338.3	1334.3	1332.8	1331.1	1328.7	1325.4	1323.7	1328.7	300
325	3127	3127	3126	3125	3116	3106	3083	3031	2970	2890	2811	1488.6	1475.5	1471.8	1467.4	1461.1	1452.6	1446.0	1439.1	325
350	3177	3177	3177	3176	3168	3159	3139	3095	3046	2990	2926	2855	1647.1	1636.5	1625.0	1609.9	1589.6	1576.3	1570.5	350
375	3228	3228	3228	3227	3220	3211	3194	3156	3115	3069	3019	2862	2604	2319	1849	1791	1748	1716	1671	375
400	3280	3280	3279	3278	3272	3264	3249	3216	3180	3142	3100	2979	2820	2733	2582	2262	1934	1878	1798	400
425	3331	3331	3331	3330	3325	3317	3303	3274	3243	3209	3174	3075	2957	2899	2810	2619	2208	2068	1924	425
450	3384	3384	3383	3382	3377	3371	3358	3331	3303	3274	3244	3160	3064	3020	2954	2826	2516	2293	2051	450
475	3436	3436	3436	3433	3430	3424	3412	3388	3363	3337	3310	3237	3157	3120	3068	2969	2743	2522	2181	475
500	3489	3489	3489	3488	3484	3478	3467	3445	3422	3399	3375	3311	3241	3210	3166	3085	2907	2723	2316	500
550	3597	3596	3596	3596	3592	3587	3578	3559	3539	3520	3500	3448	3394	3370	3337	3277	3152	3031	2594	550
600	3706	3706	3705	3705	3704	3697	3689	3673	3656	3640	3623	3580	3536	3516	3490	3443	3346	3248	2857	600
650	3816	3816	3816	3816	3813	3809	3802	3788	3774	3759	3745	3708	3671	3655	3633	3595	3517	3439	3105	650
700	3929	3929	3929	3928	3926	3923	3916	3904	3892	3879	3867	3835	3804	3790	3772	3740	3675	3610	3324	700
750	4043	4043	4043	4043	4040	4038	4032	4021	4011	4000	3989	3962	3935	3923	3908	3880	3825	3771	3526	750
800	4159	4159	4159	4158	4156	4154	4149	4140	4131	4121	4112	4089	4065	4055	4042	4018	3972	3925	3714	800

Lecture no. 1 – How to use steam tables-Cont.

Solution cont. :

To find specific volume ,
v use table 11 page 18

Density , ρ= 4.86 kg/ m3

v= 1/ρ= 0.2057 m3/kg

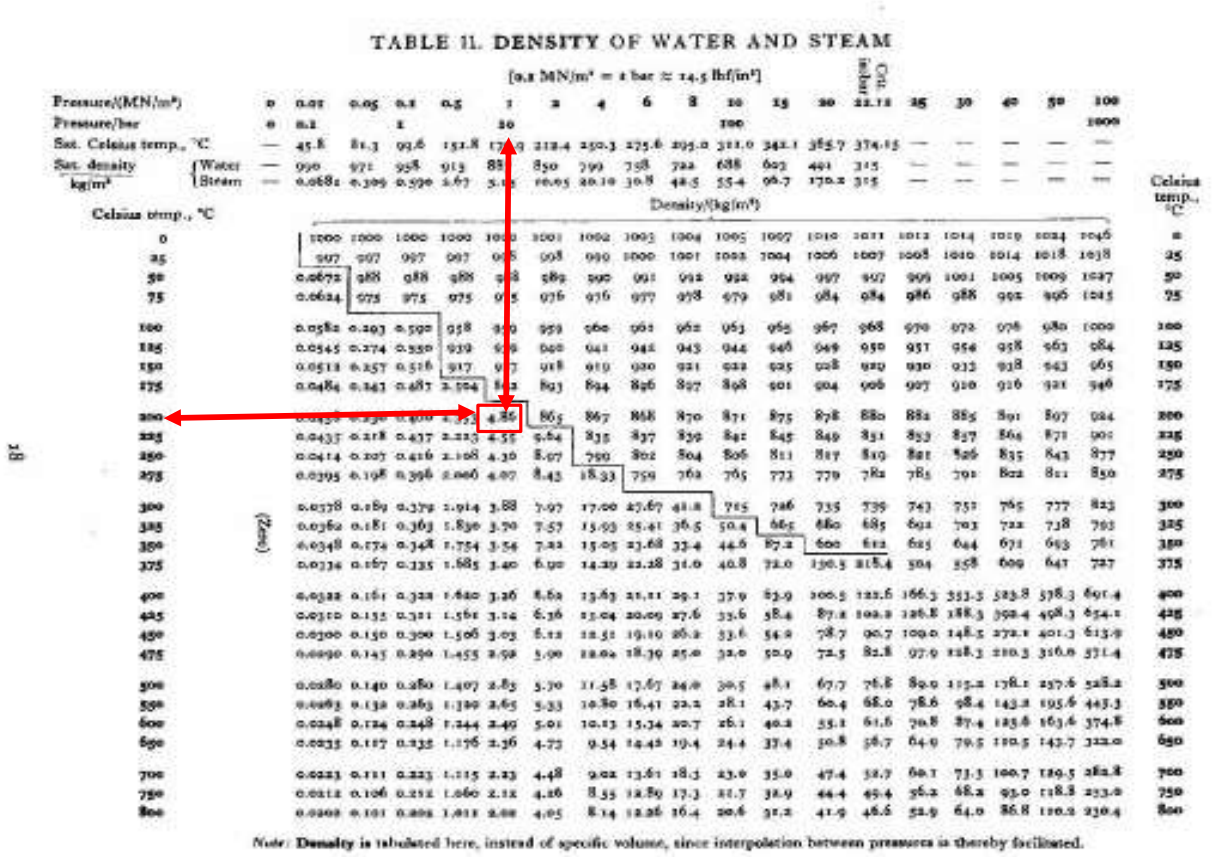

TABLE 11. DENSITY OF WATER AND STEAM

[0.1 MN/m² = 1 bar ≈ 14.5 lbf/in²]

Pressure/(MN/m²)	0	0.01	0.05	0.1	0.5	1	2	4	6	8	10	15	20	22.12	25	30	40	50	100
Pressure/bar	0	0.1		1		10					100								1000
Sat. Celsius temp., °C	—	45.8	81.3	99.6	151.8	179.9	212.4	250.3	275.6	295.0	311.0	342.1	365.7	374.15	—	—	—	—	—
Sat. density kg/m³ Water	—	990	971	958	913	887	850	799	758	722	688	603	491	315	—	—	—	—	—
Sat. density kg/m³ Steam	—	0.0682	0.305	0.590	2.67	5.15	10.05	20.10	30.8	42.5	55.4	90.7	170.2	315	—	—	—	—	—

Celsius temp., °C	Density/(kg/m³)																		Celsius temp., °C
0	1000	1000	1000	1000	1000	1001	1002	1003	1004	1005	1007	1010	1011	1012	1014	1019	1024	1046	0
25	997	997	997	997	998	998	999	1000	1001	1002	1004	1006	1007	1008	1010	1014	1018	1038	25
50	0.0672	988	988	988	988	989	990	991	992	992	994	997	997	998	1001	1005	1009	1027	50
75	0.0624	975	975	975	975	976	976	977	978	979	981	984	984	986	988	992	996	1015	75
100	0.0582	0.293	0.590	958	959	959	960	961	962	963	965	967	968	970	972	976	980	1000	100
125	0.0545	0.274	0.550	939	939	940	941	942	943	944	946	949	950	951	954	958	963	984	125
150	0.0513	0.257	0.516	917	917	918	919	920	921	922	925	928	929	930	933	938	943	965	150
175	0.0484	0.243	0.487	2.504	893	893	894	896	897	898	901	904	906	907	910	916	921	946	175
200	0.0459	0.230	0.460	2.353	4.86	865	867	868	870	871	875	878	880	882	885	891	897	924	200
225	0.0437	0.218	0.437	2.223	4.53	5.64	835	837	839	841	845	849	851	853	857	864	871	901	225
250	0.0414	0.207	0.416	2.108	4.30	5.07	790	802	804	806	811	817	819	821	826	835	843	877	250
275	0.0395	0.198	0.396	2.006	4.07	4.43	18.33	759	762	765	773	779	782	785	791	802	811	850	275
300	0.0378	0.189	0.379	1.914	3.88	3.97	17.00	25.67	41.8	715	736	735	739	743	751	765	777	823	300
325	0.0362	0.181	0.363	1.830	3.70	3.57	15.93	25.41	36.5	50.4	665	680	685	692	703	722	738	793	325
350	0.0348	0.174	0.348	1.754	3.54	3.22	15.05	23.68	33.4	44.6	57.2	600	612	625	644	671	693	761	350
375	0.0334	0.167	0.335	1.685	3.40	2.90	14.29	22.28	31.0	40.8	52.0	130.5	215.4	504	558	609	647	727	375
400	0.0322	0.161	0.322	1.620	3.26	2.62	13.63	21.11	29.1	37.9	47.9	100.5	122.6	166.3	353.3	523.8	578.3	691.4	400
425	0.0310	0.155	0.311	1.561	3.14	2.36	13.04	20.09	27.6	35.6	44.8	87.1	100.2	126.8	188.3	392.4	458.3	654.1	425
450	0.0300	0.150	0.300	1.506	3.03	2.12	12.51	19.10	26.2	33.6	42.0	78.7	90.7	109.0	148.5	272.1	401.3	613.9	450
475	0.0290	0.145	0.290	1.455	2.92	1.90	12.02	18.39	25.0	32.0	40.0	72.5	82.8	97.9	128.3	210.3	316.0	571.4	475
500	0.0280	0.140	0.280	1.407	2.83	1.70	11.58	17.67	24.0	30.5	38.1	67.7	76.8	89.0	115.2	178.1	257.6	528.2	500
550	0.0263	0.132	0.263	1.330	2.65	1.53	10.80	16.41	22.2	28.1	35.1	60.4	68.0	78.6	98.4	143.2	195.6	443.3	550
600	0.0248	0.124	0.248	1.244	2.49	1.01	10.13	15.34	20.7	26.1	32.2	55.1	61.6	70.8	87.4	123.8	163.4	374.8	600
650	0.0233	0.117	0.233	1.176	2.36	4.72	9.54	14.42	19.4	24.4	30.1	50.8	56.7	64.9	79.5	110.5	142.7	322.0	650
700	0.0223	0.111	0.223	1.115	2.23	4.48	9.02	13.61	18.3	23.0	28.3	47.4	52.7	60.1	73.3	100.7	129.5	282.8	700
750	0.0212	0.106	0.212	1.060	2.12	4.26	8.55	12.89	17.3	21.7	26.9	44.4	49.4	56.2	68.2	93.0	118.8	253.0	750
800	0.0202	0.101	0.202	1.011	2.02	4.05	8.14	12.26	16.4	20.6	25.2	41.9	46.6	52.9	64.0	86.8	110.2	230.4	800

Note: Density is tabulated here, instead of specific volume, since interpolation between pressures is thereby facilitated.

Lecture no. 1 – How to use steam tables-Cont.

Solution cont. :

To find internal energy, u use table 12 page 19

u= 2621 kJ/kg

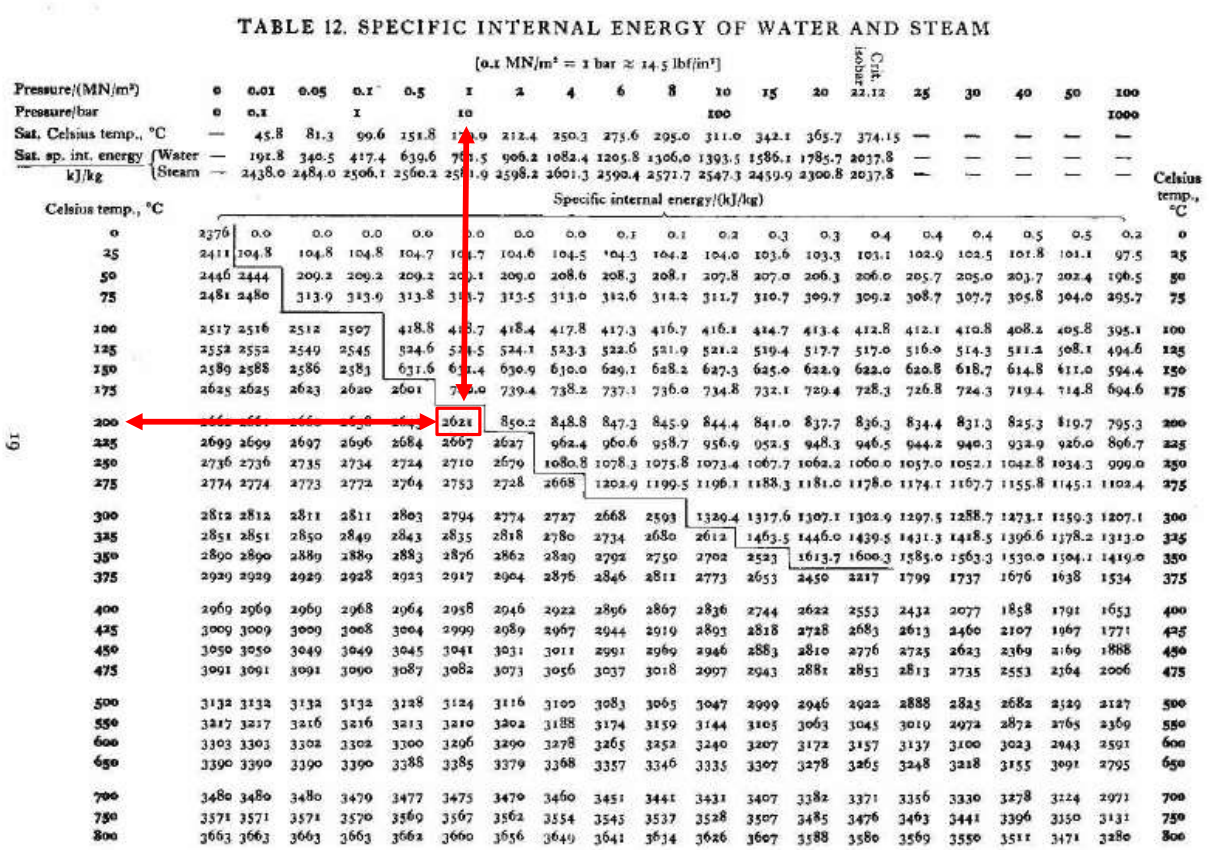

TABLE 12. SPECIFIC INTERNAL ENERGY OF WATER AND STEAM

[0.1 MN/m² = 1 bar ≈ 14.5 lbf/in²]

Pressure/(MN/m²)	0	0.01	0.05	0.1	0.5	1	2	4	6	8	10	15	20	Critical 22.12	25	30	40	50	100
Pressure/bar	0	0.1		1		10					100								1000
Sat. Celsius temp., °C	—	45.8	81.3	99.6	151.8	179.9	212.4	250.3	275.6	295.0	311.0	342.1	365.7	374.15	—	—	—	—	—
Sat. sp. int. energy kJ/kg {Water	—	191.8	340.5	417.4	639.6	762.5	906.2	1082.4	1205.8	1306.0	1393.5	1586.1	1785.7	2037.8	—	—	—	—	—
{Steam	—	2438.0	2484.0	2506.1	2560.2	2581.9	2598.2	2601.3	2590.4	2571.7	2547.3	2459.9	2300.8	2037.8	—	—	—	—	—

Specific internal energy/(kJ/kg)

Celsius temp., °C																			Celsius temp., °C
0	2376	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.2	0
25	2411	104.8	104.8	104.8	104.7	104.7	104.6	104.5	104.3	104.2	104.0	103.6	103.3	103.1	102.9	102.5	101.8	101.1	97.5	25
50	2446	2444	209.2	209.2	209.2	209.1	209.0	208.6	208.3	208.1	207.8	207.0	206.3	206.0	205.7	205.0	203.7	202.4	196.5	50
75	2481	2480	313.9	313.9	313.8	313.7	313.5	313.0	312.6	312.2	311.7	310.7	309.7	309.2	308.7	307.7	305.8	304.0	295.7	75
100	2517	2516	2512	2507	418.8	418.7	418.4	417.8	417.3	416.7	416.1	414.7	413.4	412.8	412.1	410.8	408.2	405.8	395.1	100
125	2552	2552	2549	2545	524.6	524.5	524.1	523.3	522.6	521.9	521.2	519.4	517.7	517.0	516.0	514.3	511.2	508.1	494.6	125
150	2589	2588	2586	2583	631.6	631.4	630.9	630.0	629.1	628.2	627.3	625.0	622.9	622.0	620.8	618.7	614.8	611.0	594.4	150
175	2625	2625	2623	2620	2601	738.0	739.4	738.2	737.1	736.0	734.8	732.1	729.4	728.3	726.8	724.3	719.4	714.8	694.6	175
200	2662	2661	2660	2658	2647	2621	850.2	848.8	847.3	845.9	844.4	841.0	837.7	836.3	834.4	831.3	825.3	819.7	795.3	200
225	2699	2699	2697	2696	2684	2667	2627	962.4	960.6	958.7	956.9	952.5	948.3	946.5	944.2	940.3	932.9	926.0	896.7	225
250	2736	2736	2735	2734	2724	2710	2679	1080.8	1078.3	1075.8	1073.4	1067.7	1062.2	1060.0	1057.0	1052.1	1042.8	1034.3	999.0	250
275	2774	2774	2773	2772	2764	2753	2728	2668	1202.9	1199.5	1196.1	1188.3	1181.0	1178.0	1174.1	1167.7	1155.8	1145.1	1102.4	275
300	2812	2812	2811	2811	2803	2794	2774	2727	2668	2593	1329.4	1317.6	1307.1	1302.9	1297.5	1288.7	1273.1	1259.3	1207.1	300
325	2851	2851	2850	2849	2843	2835	2818	2780	2734	2680	2612	1463.5	1446.0	1439.5	1431.3	1418.5	1396.6	1378.2	1313.0	325
350	2890	2890	2889	2889	2883	2876	2862	2829	2792	2750	2702	2523	1613.7	1600.3	1585.0	1563.3	1530.0	1504.1	1419.0	350
375	2929	2929	2929	2928	2923	2917	2904	2876	2846	2811	2773	2653	2450	2217	1799	1737	1676	1638	1534	375
400	2969	2969	2969	2968	2964	2958	2946	2922	2896	2867	2836	2744	2622	2553	2432	2077	1858	1791	1653	400
425	3009	3009	3009	3008	3004	2999	2989	2967	2944	2919	2893	2818	2728	2683	2613	2460	2107	1967	1771	425
450	3050	3050	3049	3049	3045	3041	3031	3011	2991	2969	2946	2883	2810	2776	2725	2623	2369	2169	1888	450
475	3091	3091	3091	3090	3087	3082	3073	3056	3037	3018	2997	2943	2881	2851	2813	2735	2553	2364	2006	475
500	3132	3132	3132	3132	3128	3124	3116	3100	3083	3065	3047	2999	2946	2922	2888	2825	2682	2529	2127	500
550	3217	3217	3216	3216	3213	3210	3202	3188	3174	3159	3144	3105	3063	3045	3019	2972	2872	2765	2369	550
600	3303	3303	3302	3302	3300	3296	3290	3278	3265	3252	3240	3207	3172	3157	3137	3100	3023	2943	2591	600
650	3390	3390	3390	3390	3388	3385	3379	3368	3357	3346	3335	3307	3278	3265	3248	3218	3155	3091	2795	650
700	3480	3480	3480	3479	3477	3475	3470	3460	3451	3441	3431	3407	3382	3371	3356	3330	3278	3224	2971	700
750	3571	3571	3571	3570	3569	3567	3562	3554	3545	3537	3528	3507	3485	3476	3463	3441	3396	3350	3131	750
800	3663	3663	3663	3663	3662	3660	3656	3649	3641	3634	3626	3607	3588	3580	3569	3550	3511	3471	3280	800

Lecture no. 1 – How to use steam tables-Cont.

HOME WORK :

Q1 : Calculate the dryness fraction , internal energy, and specific volume for steam at 8 bar and the specific enthalpy of 2650 kJ/kg.

Q2 : Steam at a pressure of 100 bar and specific volume of 0.02242 m3/kg , calculate its temperature, specific enthalpy and internal energy.

Q3: Steam at 150 bar and specific enthalpy of 2979 KJ/kg , determine the temperature , specific volume and the internal energy.

Q4: A vessel of a volume 0.03m3 contains dry saturated steam at 20 bar, calculate the mass of steam in vessel and the enthalpy of this mass.

Lecture no. 1 – How to use steam tables-Cont.

Steam at 7 bar and 250 °C enters a pipeline and flows along it at constant pressure. If the steam rejects heat steadily to the surroundings, at what temperature will droplets of water begin to form in the vapour? Using the steady-flow energy equation, and neglecting changes in velocity of the steam, calculate the heat rejected per kilogram of steam flowing.

(165 °C; 191 kJ/kg)

0.05 kg of steam at 15 bar is contained in a rigid vessel of volume 0.0076 m^3. What is the temperature of the steam? If the vessel is cooled, at what temperature will the steam be just dry saturated? Cooling is continued until the pressure in the vessel is 11 bar; calculate the final dryness fraction of the steam, and the heat rejected between the initial and the final states.

(250 °C; 191.4 °C; 0.857; 18.5 kJ)