Calculation of Superheated Steam Enthalpy and Density with the new 'Zpbe' equation for Pressures 1 - 140 Bar and Temperatures 100 – 700 Degr. Celsius.

(4 Feb 2021 - by AE for myChemEngmusings.Wordpress.com)

The newly discovered and modeled Z*pbe* equation as described in the previous post of 16 Nov 2020 [1] allows the compressibility factor Z to be calculated directly from a corresponding states relation written into a single cell of an (excel) spreadsheet for components with a Zc factor equal or close to 0.27.
In this post the Z*pbe* equation has been modified, in particular the temperature dependence, to allow application to Water which has a very different critical compressibility factor of Zc = 0.2294. With the help of this new Z*pbe-h2o* equation it is shown here that the Superheated Steam Enthalpy and Density can be straightforwardly calculated with high accuracy over a wide range of Superheated Steam pressures and temperatures.

Three equations will be presented below: 1) the Enthalpy of superheated Steam and 2) the Density of superheated Steam and 3) the Zpbe-H2O equation for superheated Steam.

Part I The three Equations

1) The enthalpy of superheated steam can be calculated from:

   H*steamsup* **= 1892 + 4.52 * Z***pbe-H2O* *** R / MW * T …….(Eq. 1)**

   The symbols have the following meaning: H*steamsup* is the Enthalpy H of superheated steam in kJ /kg ; R is the Universal Gas Constant with value of 8.3145 kJ/kmol/oK ; MW is Mol. weight water is 18 ; T the absolute temperature in degrees Kelvin. The average percentage error compared with Grigull Steam Tables is 0.23 % over the following pressure and Temperature ranges: 1 < P < 140 Bar abs and 373 < T < 973 degr. Kelvin.

2) Density of superheated Steam:

   D*steamsup* **= P * 100 * MW / (Z***pbe-H2O* *** R * T) ……..(Eq.2)**

   The symbols are: D*steamsup* is the superheated steam density in kg per m3 ; P is the absolute pressure in Bar absolute ; other symbols as in equation (Eq.1). The average percentage error is 0.16% over the same range of conditions.

3) The compressibility factor Z for Superheated Steam:

   Z*pbe-h2o* = **1 – 0.3411 / Tr^4.111 * Pr / (1 – 0.3411 / Tr^4.111 * Pr) …..(Eq.3)**

   The symbol **Z***pbe-h2o* stands for the compressibility factor of superheated steam ; the symbol Tr stands for the reduced Temperature equal to T / Tc in which the critical temperature is 647.14 degrees Kelvin ; and Pr stands for the reduced

pressure equal to P /Pc in which the critical pressure is 220.64 Bara abs. The average percentage error in calculated Z value is 0.16% !

Part II Some Calculation examples

To calculate the superheated steam enthalpy we begin first with Eq.3 to calculate the Z factor value for the pertinent conditions of practical interest.

(a) for a Steam Temperature of 375 oC and a Pressure of 60 Bara, with approx 100 degrees Celsius of superheat ; the reduced temperature Tr = 1.001576 and the reduced pressure Pr = 0.271936

Z*pbe-h2o* = 1- 0.3411/ 1.00158^4.111 * 0.27194 /(1- 0.3411 /1.00158^4.111 * 0.27194)

= = => **Z***pbe-h2o* = 0.8985 The Steam Table value is 0.9001.

(b) Summary Table of some more examples

Examples Superheated Steam Operating Conditions & calculation Results						
Oper. Pressure (Bar abs)	**5**	**15**	**45**	**60**	**120**	**200**
Reduced Pressure Pr	0.02266	0.06798	0.20400	0.27194	0.54387	0.90645
Oper. Temp. (Deg. Celsius)	**225**	**300**	**400**	**400**	**500**	**450**
Degrees Superheat (oC)	73	102	143	125	175	82
Abs. Temp. (Deg. Kelvin)	498.14	573.14	673.14	673.14	773.14	723.14
Reduced Temp. Tr	0.7698	0.8857	1.0402	1.0402	1.1947	1.1174
Calculation Results						
Calc. **Z***pbe-h2o* (----)	0.9768	0.9603	0.9371	0.9144	0.9020	0.7564
Steam Table value Z (----)	0.9782	0.9620	0.9378	0.9152	0.9013	0.7611
Calc. **H***steamsup* (kJ/kg)	2908	3041	3209	3177	3348	3034
Steam Table value (kJ/kg)	2907	3036	3204	3177	3348	3060
Calc. **D***steamsup* (kg/m3)	2.226	5.905	15.457	21.12	37.29	79.22
Steam Table value (kg/m3)	2.223	5.894	15.446	21.10	37.13	78.73

Part III The Basis for the new **Z***pbe-h2o* Equation for superheated Steam

In the previous post a new expression was found for the compressibility factor Z based on consideration and numerical data for the fugacity and the Z factor for compounds with a critical Z factor of 0.27. This equation was named the “Zpbe” equation. The form of this equation inspired a theoretical derivation for this equation (see post). This equation can be cast in the following form :

Zpbe = 1 - Keq * Pr / (1- Keq * Pr)

in which Keq is the equilibrium constant. For compounds with a Zc of 0.27 the equilibrium constant equals Keq = 0.333 / Tr^3.905.

The question was how can this equation be applied to compounds with very different Zc ! A compound like Water with its very low Zc of 0.2294 ? Or for Lee-Kesler's " Simple Fluid with Zc=0.2901 " ?

The answer was found in the realization of what the meaning of the equilibrium constant was, what it represented! In the developed model it stood for the ratio of fractions of molecules behaving like ideal gas and the fraction of molecules undergoing attraction forces; both fractions of gas molecules present in any real gas mixture below the critical temperature (Tr < 1.0).
Thinking of ideal gas we must think of gas particles only possessing kinetic energy! This means the mass and the velocity of the particle are influencing it's kinetic energy. Thus the mass hence the Molecular weight and the absolute temperature (no. of degr of freedom * kT) must influence the fraction of gas molecules behaving like ideal gas molecules in that real gas mixture at the given T and P ! And hence affect the equilibrium constant Keq.

This reasoning lead to concluding that each compound has its own Keq relation.
The original equilibrium relation for compounds equal or close to Zc =0.27 was found being :

Keq = Ck / Tr^m with Ck = 0.333 and exponent m = 3.905

For Water, superheated Steam over a Temperature range of 100 – 700 oC
and Pressures of 1 – 200 Bar abs I found:

Keq = Ck / Tr^m with Ck = 0.3411 and m = 4.111

Similarly for Lee Kesler's "Simple Fluid Zc = 0.2901 " I found

Keq = Ck / Tr^m with Ck =0.320 and m = 3.20

This latter relation I will come back to in a future post.

Ref. [1] Post of 16 Nov 2020 titled "Two simple yet accurate equations for calculating the fugacity coefficient phi and the gas compressibility factor Z.

https://mychemengmusings.wordpress.com/2020/11/16/two-simple-yet-accurate-equations-for-calculating-the-fugacity-coefficient-phi-and-the-gas-compressibility-factor-z/

Attached excel worksheet Superheated steam Table values plus calculations (2 pages)

End post.

Superheated STEAM Calculation of Superheated Steam Z values with the help of the new Zpbe-H2O equation

Comparison of calculated Zpbe-H2O values with Z-actual (derived from primary Steam Table values) Steam Tables from U.Grigull et al.

Tabulated data shown **in bold**

Superheated Steam temp. oC	Temp. oK	T/Tc ---	Degrees superheat oC	Saturation temp. oC	Superheated Steam Pressure Barabs	P/Pc ---	STEAM Density kg/m3	Z actual	STEAM Enthalpy Hv Table kJ/kg	----- Zpbe-h2o ----- m= 4.1110 stdev= 0.163 Ck = 0.34110 Error% 0.163	--- Hsteamsuper --- kJ/kg fct= 1.1300 stdev= 0.156 Uo= 1892 Error% 0.232	--- Dsteamsuper --- kg/m3 stdev= 0.162 Error% 0.163
125	398.14	0.6152	25.2	99.8	**1.0**	0.00453	**0.5503**	0.989	**2726**	0.9885 0.04	2714 0.45	0.5506 0.04
150	423.14	0.6539	50.2	99.8	**1.0**	0.00453	**0.5164**	0.992	**2776**	0.9911 0.05	2768 0.30	0.5167 0.05
175	448.14	0.6925	75.2	99.8	**1.0**	0.00453	**0.4867**	0.993	**2825**	0.9929 0.05	2821 0.14	0.4869 0.05
200	473.14	0.7311	100.2	99.8	**1.0**	0.00453	**0.4603**	0.995	**2874**	0.9944 0.04	2874 0.01	0.4605 0.04
225	498.14	0.7698	125.2	99.8	**1.0**	0.00453	**0.4368**	0.996	**2924**	0.9954 0.03	2927 0.11	0.4370 0.03
250	523.14	0.8084	150.2	99.8	**1.0**	0.00453	**0.4156**	0.997	**2973**	0.9963 0.03	2980 0.24	0.4157 0.03
275	548.14	0.8470	175.2	99.8	**1.0**	0.00453	**0.3964**	0.997	**3023**	0.9969 0.02	3033 0.33	0.3965 0.02
300	573.14	0.8857	200.2	99.8	**1.0**	0.00453	**0.3790**	0.998	**3073**	0.9974 0.01	3086 0.41	0.3790 0.01
175	448.14	0.6925	23.0	152.0	**5.0**	0.02266	**2.504**	0.965	**2800**	0.9637 0.17	2794 0.22	2.5085 0.17
200	473.14	0.7311	48.0	152.0	**5.0**	0.02266	**2.354**	0.973	**2854**	0.9712 0.17	2851 0.09	2.3577 0.17
225	498.14	0.7698	73.0	152.0	**5.0**	0.02266	**2.223**	0.9782	**2907**	0.9768 0.15	2908 0.03	2.2264 0.15
250	523.14	0.8084	98.0	152.0	**5.0**	0.02266	**2.108**	0.982	**2960**	0.9811 0.12	2964 0.12	2.1107 0.12
275	548.14	0.8470	123.0	152.0	**5.0**	0.02266	**2.006**	0.985	**3011**	0.9845 0.09	3019 0.25	2.0076 0.09
300	573.14	0.8857	148.0	152.0	**5.0**	0.02266	**1.914**	0.988	**3063**	0.9871 0.06	3073 0.33	1.9149 0.06
325	598.14	0.9243	173.0	152.0	**5.0**	0.02266	**1.830**	0.990	**3115**	0.9892 0.05	3127 0.40	1.8310 0.05
200	473.14	0.7311	20.0	180.0	**10**	0.04532	**4.857**	0.943	**2827**	0.9407 0.24	2821 0.20	4.8683 0.24
225	498.14	0.7698	45.0	180.0	**10**	0.04532	**4.555**	0.955	**2885**	0.9525 0.25	2883 0.08	4.5665 0.25
250	523.14	0.8084	70.0	180.0	**10**	0.04532	**4.298**	0.964	**2941**	0.9615 0.21	2942 0.04	4.3076 0.21
275	548.14	0.8470	95.0	180.0	**10**	0.04532	**4.075**	0.970	**2996**	0.9684 0.16	3000 0.14	4.0817 0.16
300	573.14	0.8857	120.0	180.0	**10**	0.04532	**3.877**	0.975	**3050**	0.9739 0.13	3057 0.24	3.8819 0.13
325	598.14	0.9243	145.0	180.0	**10**	0.04532	**3.700**	0.979	**3104**	0.9782 0.09	3114 0.31	3.7033 0.09
350	623.14	0.9629	170.0	180.0	**10**	0.04532	**3.540**	0.982	**3157**	0.9816 0.06	3169 0.38	3.5422 0.06
225	498.14	0.7698	26.8	198.2	**15.0**	0.06798	**7.018**	0.930	**2861**	0.9270 0.29	2856 0.17	7.0379 0.29
250	523.14	0.8084	51.8	198.2	**15.0**	0.06798	**6.582**	0.944	**2922**	0.9411 0.29	2920 0.07	6.6013 0.29
275	548.14	0.8470	76.8	198.2	**15.0**	0.06798	**6.214**	0.954	**2980**	0.9519 0.23	2981 0.05	6.2289 0.24
300	573.14	0.8857	101.8	198.2	**15.0**	0.06798	**5.894**	0.9620	**3036**	0.9603 0.18	3041 0.17	5.9052 0.18
325	598.14	0.9243	126.8	198.2	**15.0**	0.06798	**5.613**	0.968	**3092**	0.9669 0.13	3099 0.24	5.6197 0.13
350	623.14	0.9629	151.8	198.2	**15.0**	0.06798	**5.360**	0.973	**3147**	0.9722 0.08	3157 0.31	5.3650 0.08
375	648.14	1.0015	176.8	198.2	**15.0**	0.06798	**5.133**	0.977	**3201**	0.9764 0.05	3213 0.38	5.1356 0.05
225	498.14	0.7698	12.8	212.2	**20.0**	0.09065	**9.639**	0.902	**2834**	0.9003 0.24	2828 0.20	9.6626 0.24
250	523.14	0.8084	37.8	212.2	**20.0**	0.09065	**8.976**	0.923	**2901**	0.9199 0.32	2897 0.15	9.0045 0.32
275	548.14	0.8470	62.8	212.2	**20.0**	0.09065	**8.432**	0.938	**2963**	0.9348 0.29	2962 0.04	8.4569 0.29
300	573.14	0.8857	87.8	212.2	**20.0**	0.09065	**7.971**	0.949	**3022**	0.9463 0.23	3024 0.08	7.9897 0.23
325	598.14	0.9243	112.8	212.2	**20.0**	0.09065	**7.571**	0.957	**3080**	0.9554 0.17	3085 0.16	7.5834 0.17
350	623.14	0.9629	137.8	212.2	**20.0**	0.09065	**7.217**	0.964	**3136**	0.9625 0.11	3144 0.26	7.2249 0.11
375	648.14	1.0015	162.8	212.2	**20.0**	0.09065	**6.900**	0.969	**3192**	0.9683 0.06	3202 0.32	6.9048 0.06
400	673.14	1.0402	187.8	212.2	**20.0**	0.09065	**6.614**	0.973	**3247**	0.9730 0.03	3259 0.38	6.6163 0.03
250	523.14	0.8084	26.3	223.7	**25.0**	0.11331	**11.497**	0.901	**2879**	0.8979 0.30	2873 0.22	11.5321 0.30
275	548.14	0.8470	51.3	223.7	**25.0**	0.11331	**10.739**	0.920	**2945**	0.9172 0.33	2942 0.11	10.7745 0.33
300	573.14	0.8857	76.3	223.7	**25.0**	0.11331	**10.113**	0.935	**3007**	0.9320 0.27	3007 0.01	10.1407 0.27
325	598.14	0.9243	101.3	223.7	**25.0**	0.11331	**9.579**	0.945	**3067**	0.9436 0.20	3070 0.11	9.5977 0.20
350	623.14	0.9629	126.3	223.7	**25.0**	0.11331	**9.112**	0.954	**3125**	0.9527 0.14	3132 0.21	9.1241 0.14
375	648.14	1.0015	151.3	223.7	**25.0**	0.11331	**8.698**	0.961	**3182**	0.9601 0.08	3191 0.29	8.7051 0.08
400	673.14	1.0402	176.3	223.7	**25.0**	0.11331	**8.327**	0.966	**3239**	0.9660 0.04	3250 0.33	8.3302 0.04
450	723.14	1.1174	226.3	223.7	**25.0**	0.11331	**7.685**	0.975	**3350**	0.9749 0.01	3364 0.42	7.6835 0.01
500	773.14	1.1947	276.3	223.7	**25.0**	0.11331	**7.144**	0.981	**3462**	0.9810 0.04	3476 0.39	7.1416 0.04
275	548.14	0.8470	17.9	257.1	**45.0**	0.20395	**21.148**	0.841	**2862**	0.8404 0.09	2854 0.29	21.167 0.09
300	573.14	0.8857	42.9	257.1	**45.0**	0.20395	**19.481**	0.873	**2942**	0.8706 0.31	2934 0.28	19.541 0.31
325	598.14	0.9243	67.9	257.1	**45.0**	0.20395	**18.182**	0.897	**3013**	0.8936 0.32	3008 0.17	18.242 0.33
350	623.14	0.9629	92.9	257.1	**45.0**	0.20395	**17.141**	0.913	**3079**	0.9116 0.14	3078 0.03	17.165 0.14
375	648.14	1.0015	117.9	257.1	**45.0**	0.20395	**16.227**	0.927	**3143**	0.9257 0.14	3145 0.06	16.250 0.14
400	673.14	1.0402	142.9	257.1	**45.0**	0.20395	**15.446**	0.9378	**3204**	0.9371 0.07	3209 0.16	15.457 0.07
450	723.14	1.1174	192.9	257.1	**45.0**	0.20395	**14.138**	0.954	**3323**	0.9539 0.02	3332 0.28	14.135 0.02
500	773.14	1.1947	242.9	257.1	**45.0**	0.20395	**13.072**	0.965	**3439**	0.9654 0.06	3450 0.33	13.064 0.06

Tabulated data shown **in bold**

Superheated Steam temp. oC	Temp. oK	T/Tc ---	Degrees superheat oC	Saturation temp. oC	Superheated Steam Pressure Barabs	P/Pc ---	STEAM Density kg/m3	Z actual	STEAM Enthalpy Hv Table kJ/kg	----- Zpbe-h2o ----- m= 4.1110 Ck = *0.34110*	stdev= 0.163 Error% ***0.163***	--- Hsteamsuper --- kJ/kg fct= 1.1300 Uo= 1892	stdev= 0.156 Error% ***0.232***	--- Dsteamsuper --- kg/m3	stdev= 0.162 Error% ***0.163***
300	573.14	0.8857	24.8	275.2	**60.0**	0.27194	**27.662**	0.820	**2883**	0.8196	0.05	2873	0.35	27.674	0.05
325	598.14	0.9243	49.8	275.2	**60.0**	0.27194	**25.412**	0.855	**2967**	0.8529	0.28	2957	0.33	25.482	0.28
350	623.14	0.9629	74.8	275.2	**60.0**	0.27194	**23.687**	0.881	**3042**	0.8785	0.26	3035	0.23	23.748	0.26
375	648.14	1.0015	99.8	275.2	**60.0**	0.27194	**22.284**	0.900	**3111**	0.8985	0.18	3108	0.10	22.324	0.18
400	673.14	1.0402	124.8	275.2	**60.0**	0.27194	**21.101**	0.9152	**3177**	0.9144	0.10	3177	0.00	21.122	0.10
450	723.14	1.1174	174.8	275.2	**60.0**	0.27194	**19.180**	0.937	**3301**	0.9376	0.03	3308	0.20	19.175	0.03
500	773.14	1.1947	224.8	275.2	**60.0**	0.27194	**17.653**	0.953	**3422**	0.9533	0.08	3431	0.26	17.639	0.08
325	598.14	0.9243	21.8	303.2	**90.0**	0.40790	**42.996**	0.758	**2854**	0.7619	0.48	2843	0.37	42.791	0.48
350	623.14	0.9629	46.8	303.2	**90.0**	0.40790	**38.776**	0.807	**2955**	0.8059	0.14	2941	0.49	38.829	0.14
375	648.14	1.0015	71.8	303.2	**90.0**	0.40790	**35.760**	0.841	**3040**	0.8396	0.21	3028	0.39	35.836	0.21
400	673.14	1.0402	96.8	303.2	**90.0**	0.40790	**33.410**	0.867	**3117**	0.8658	0.15	3109	0.26	33.460	0.15
450	723.14	1.1174	146.8	303.2	**90.0**	0.40790	**29.855**	0.9032	**3256**	0.9033	0.01	3256	0.00	29.852	0.01
500	773.14	1.1947	196.8	303.2	**90.0**	0.40790	**27.198**	0.927	**3386**	0.9282	0.09	3390	0.13	27.173	0.09
550	823.14	1.2720	246.8	303.2	**90.0**	0.40790	**25.086**	0.944	**3510**	0.9454	0.11	3517	0.19	25.058	0.11
350	623.14	0.9629	24.9	325.1	**120.0**	0.54387	**58.129**	0.718	**2846**	0.7234	0.77	2833	0.45	57.683	0.77
375	648.14	1.0015	49.9	325.1	**120.0**	0.54387	**51.789**	0.775	**2958**	0.7740	0.08	2939	0.63	51.829	0.08
400	673.14	1.0402	74.9	325.1	**120.0**	0.54387	**47.438**	0.814	**3050**	0.8127	0.19	3034	0.52	47.530	0.19
450	723.14	1.1174	124.9	325.1	**120.0**	0.54387	**41.459**	0.867	**3208**	0.8668	0.05	3201	0.23	41.479	0.05
500	773.14	1.1947	174.9	325.1	**120.0**	0.54387	**37.313**	0.9013	**3348**	0.9020	0.08	3348	0.00	37.285	0.08
550	823.14	1.2720	224.9	325.1	**120.0**	0.54387	**34.152**	0.925	**3480**	0.9259	0.11	3483	0.09	34.116	0.11
360	633.14	0.9784	22.5	337.5	**140.0**	0.63452	**69.430**	0.6901	**2808**	0.6897	0.05	2804	0.15	69.462	0.05
375	648.14	1.0015	37.5	337.5	**140.0**	0.63452	**64.633**	0.724	**2893**	0.7260	0.26	2874	0.64	64.464	0.26
400	673.14	1.0402	62.5	337.5	**140.0**	0.63452	**58.075**	0.776	**3001**	0.7744	0.20	2980	0.69	58.192	0.20
450	723.14	1.1174	112.5	337.5	**140.0**	0.63452	**49.813**	0.842	**3174**	0.8411	0.12	3162	0.38	49.872	0.12
500	773.14	1.1947	162.5	337.5	**140.0**	0.63452	**44.411**	0.883	**3322**	0.8837	0.03	3319	0.10	44.397	0.03
550	823.14	1.2720	212.5	337.5	**140.0**	0.63452	**40.422**	0.912	**3459**	0.9124	0.08	3460	0.03	40.388	0.08
600	873.14	1.3492	262.5	337.5	**140.0**	0.63452	**37.274**	0.932	**3590**	0.9326	0.06	3592	0.06	37.254	0.06
375	648.14	1.0015	26.3	348.7	**160.0**	0.72516	**80.212**	0.667	**2818**	0.6741	1.09	2804	0.49	79.345	1.08
400	673.14	1.0402	51.3	348.7	**160.0**	0.72516	**70.102**	0.735	**2946**	0.7336	0.15	2923	0.78	70.205	0.15
450	723.14	1.1174	101.3	348.7	**160.0**	0.72516	**58.744**	0.816	**3138**	0.8142	0.23	3121	0.53	58.881	0.23
500	773.14	1.1947	151.3	348.7	**160.0**	0.72516	**51.824**	0.865	**3295**	0.8649	0.04	3288	0.21	51.846	0.04
550	823.14	1.2720	201.3	348.7	**160.0**	0.72516	**46.882**	0.898	**3438**	0.8987	0.04	3436	0.04	46.865	0.04
600	873.14	1.3492	251.3	348.7	**160.0**	0.72516	**43.064**	0.922	**3572**	0.9222	0.02	3573	0.03	43.055	0.02
650	923.14	1.4265	301.3	348.7	**160.0**	0.72516	**39.973**	0.939	**3703**	0.9391	0.04	3702	0.03	39.990	0.04
400	673.14	1.0402	36.1	363.9	**190.0**	0.86113	**91.87**	0.666	**2852**	0.6670	0.19	2829	0.79	91.692	0.19
450	723.14	1.1174	86.1	363.9	**190.0**	0.86113	**73.432**	0.775	**3081**	0.7714	0.50	3057	0.79	73.802	0.50
500	773.14	1.1947	136.1	363.9	**190.0**	0.86113	**63.597**	0.837	**3253**	0.8354	0.23	3240	0.39	63.742	0.23
550	823.14	1.2720	186.1	363.9	**190.0**	0.86113	**56.961**	0.878	**3405**	0.8773	0.08	3400	0.15	57.005	0.08
600	873.14	1.3492	236.1	363.9	**190.0**	0.86113	**51.994**	0.907	**3545**	0.9062	0.07	3544	0.03	52.028	0.07
400	673.14	1.0402	31.5	368.5	**200.0**	0.90645	**100.54**	0.640	**2816**	0.6432	0.46	2796	0.71	100.086	0.46
450	723.14	1.1174	81.5	368.5	**200.0**	0.90645	**78.734**	0.7611	**3060**	0.7564	0.62	3034	0.85	79.223	0.62
500	773.14	1.1947	131.5	368.5	**200.0**	0.90645	**67.709**	0.828	**3239**	0.8252	0.32	3224	0.46	67.924	0.32
550	823.14	1.2720	181.5	368.5	**200.0**	0.90645	**60.427**	0.871	**3393**	0.8700	0.14	3387	0.17	60.509	0.14
600	873.14	1.3492	231.5	368.5	**200.0**	0.90645	**55.039**	0.902	**3536**	0.9008	0.10	3534	0.05	55.096	0.10
650	923.14	1.4265	281.5	368.5	**200.0**	0.90645	**50.795**	0.924	**3672**	0.9227	0.16	3670	0.05	50.877	0.16