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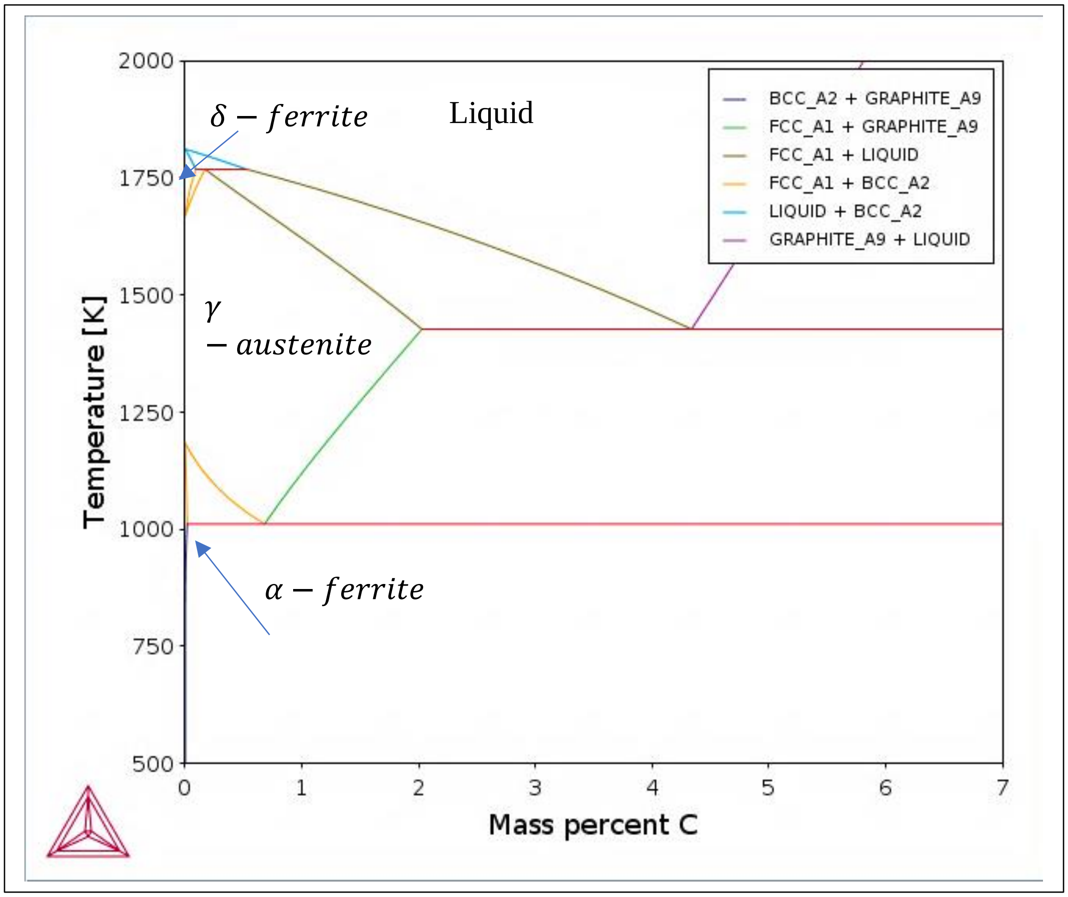
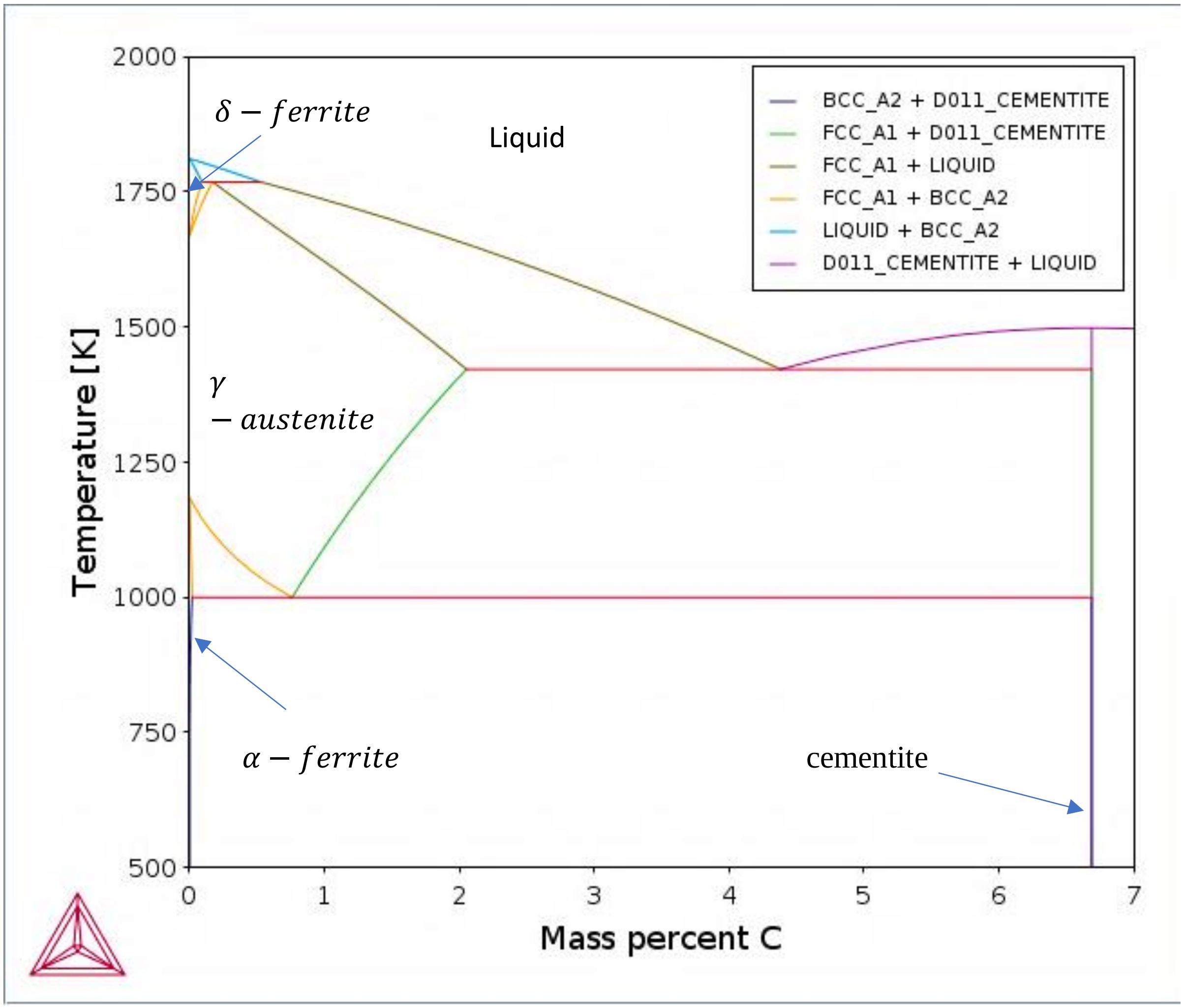
Thermocalc Module

A1.



A2.

Based on the infromation given above, the diagram might be of more enginering relevance because only 7% Mass C is observerd when graphite is a structure with 1% Mass C.



A3.

1.

(i) The temperature at the eutectic point is 1415K

(ii) This is located at 4.38 wt% C, or 95.62wt% Fe.

(iii) The eutectic reaction is from the liquid phase to cementite and + $\gamma - austenite$ phase.

2.

(i) 1600K -> 1.06 wt% C

(ii) 1500K -> 1.70 wt% C

(iii) 1400K -> 2.00 wt% C

A4.

(i) The temperature of the eutectoid temperature is 993K

(ii) The eutectoid compostion 0.82 wt% C, 99.18wt% Fe

(iii) The eutectoid reaction is $\gamma - austenite$ to $\alpha - ferrite + cementite\ phase$

A5.

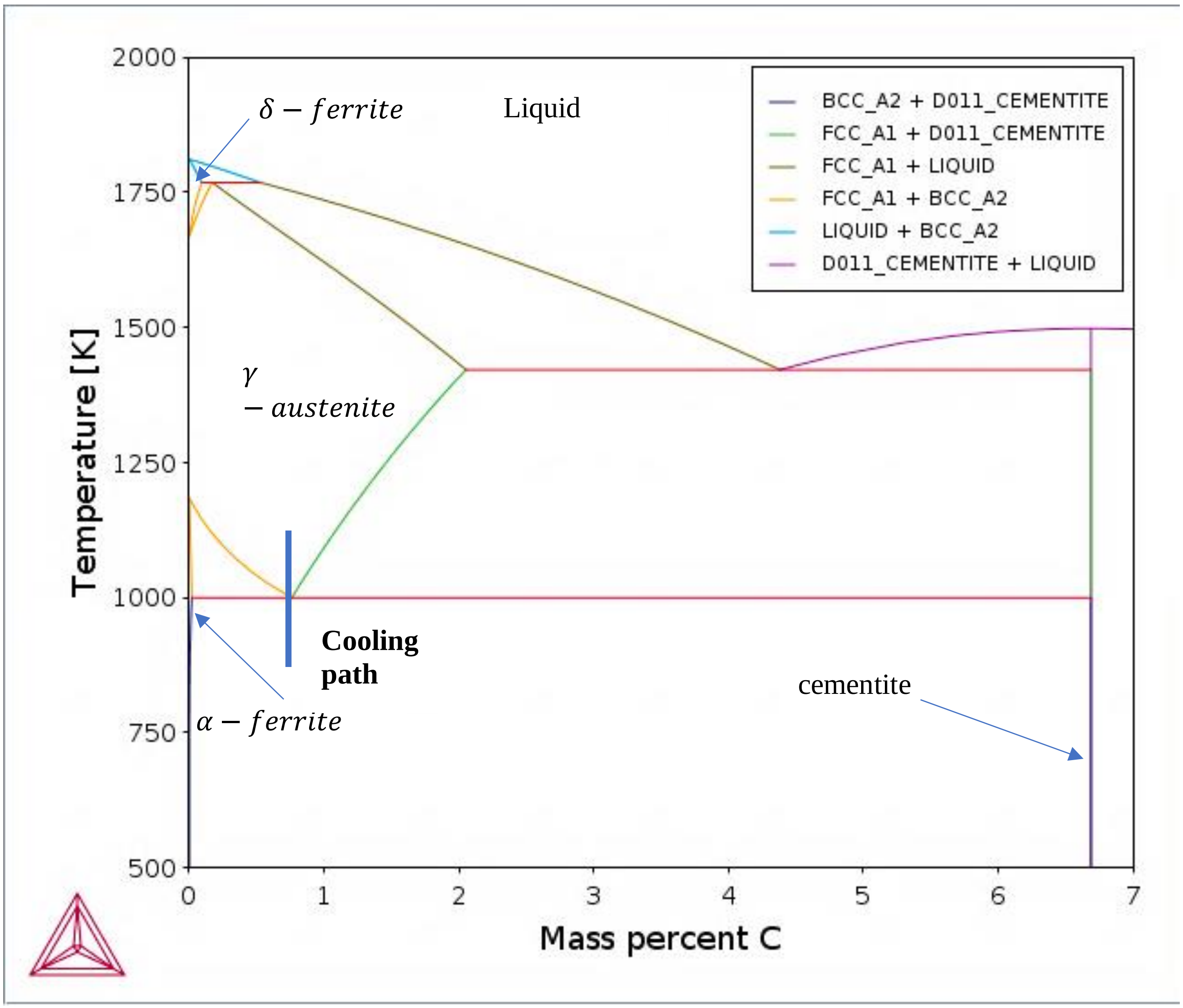
(i) The low-carbon branch of the one phase $\gamma - austenite$ low-T boundary

[T/K] = 181[wt% C]^2 - 375[wt% C] +1179

(ii) The high-carbon branch of the of the one phase $\gamma - austenite$ low-T boundary

[T/K] = -55[wt% C]^2 - 475[wt% C] + 659

A6.



- $\alpha - ferrite$ and cementite
- $\alpha - ferrite = 0.021\ wt\%\ C; cementit = 6.68\ wt\%\ C$
- Eutectoid composition = 0.761 wt% C;

$$\alpha - ferrite = \frac{6.68 - 0.761}{6.68 - 0.021} = 0.889; cementite = \frac{0.761 - 0.021}{6.68 - 0.021} = 0111$$

A7.

- Point **d** is where α phase starts to form. At point **e** proeutectoid α phase forms and at point **f** pearlite and eutectic α phase forms. Eutectoid $\alpha - ferrite$ and proeutectoid $\alpha - ferrite$ are different in that they have different temperatures of convergence where they are created. As such, protectoid α forms above eutectoid temperature whereas the eutectoid is formed below this.
- (i) $protectoid\ \alpha - ferrite = \frac{0.761-0.52}{0.761-0.021} = 0.326$

(iii) $\gamma - austenite = \frac{0.52-0.021}{0.761-0.021} = 0.674$

- (i) $\alpha - ferrite = \frac{6.68-0.52}{6.68-0.021} = 0.925$

(ii) Cementite = $\frac{0.52-0.021}{6.68-0.021} = 0.075$

(iii) $\gamma - austenite$ = 0

- (i) $protectoid\ \alpha - ferrite = \frac{0.761-0.52}{0.761-0.021} = 0.326$

(ii) $eutectoid\ \alpha - ferrite = \frac{6.68-0.52}{6.68-0.021} - \frac{0.761-0.52}{0.761-0.021} = 0.599$

A8.

1. 0.103 = ($\frac{6.68-x}{6.68-0.761}$) therefore x = 6.07 wt% C
2. 1 - ($\frac{6.07-0.761}{6.68-0.761}$) = 1.03 wt% C
3. The eutectoid point is constant in this case which means that the pearlite mass percent will not change upon further cooling.
4. α-ferrite: ($\frac{6.68-6.07}{6.68}$) 0.091 wt% C
5. This discprency can be due to the lack of data used to create an equal system all around. In addition to this, sample cooling method is very important to control and a slow cooling rate will improve accuracy the most.

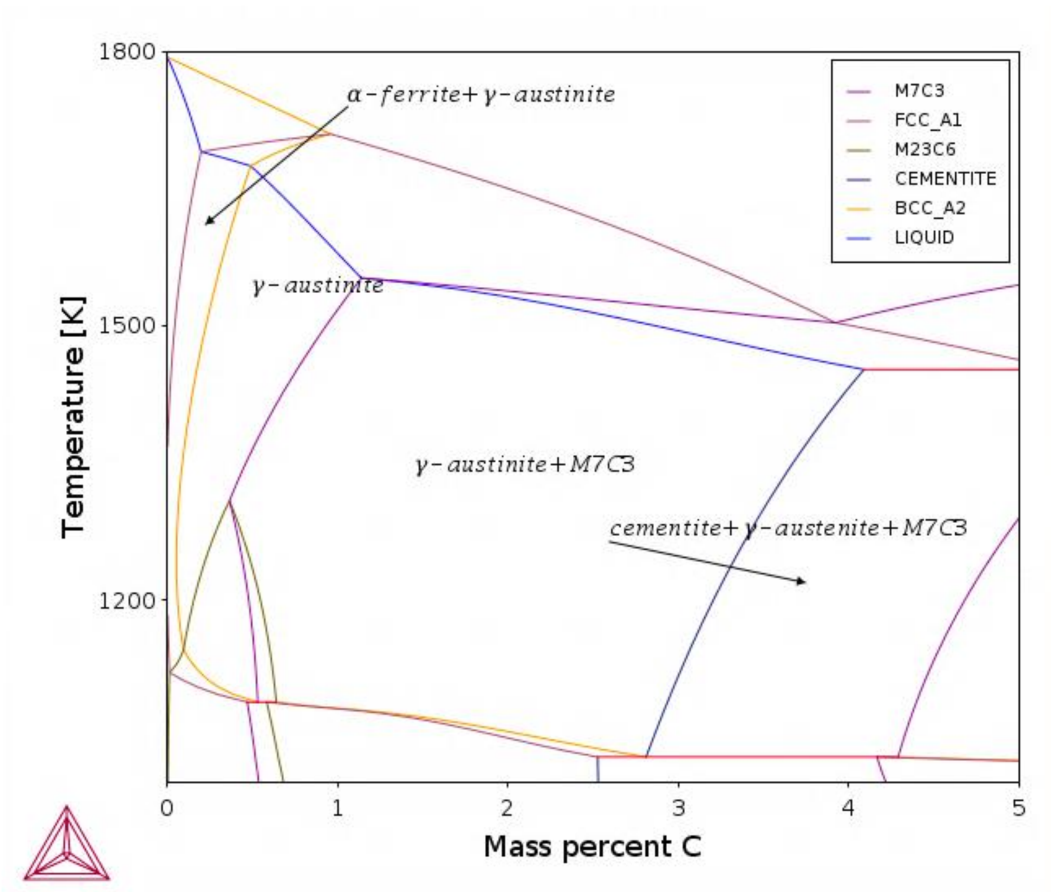
A9.

Wt % C	Wt %Cementite	Wt %Pearlite
0	0	0
0.2	2.994	26.2812
0.4	5.988	52.5624
0.6	8.982	78.8436
0.8	11.976	99.3411
1.0	14.9701	95.9622

- The trend is explained by the relationship between hardness and toughness with carbon. It is observed that carbon content increases hardness while it decreases toughness. As such since carbon in proportion with hardness and toughness they will increase and decrease respectively.

- Carbon concentration around 40 wt% C will correspond to a hardness exceeding 160 BHN and toughness of 75J.

B1.

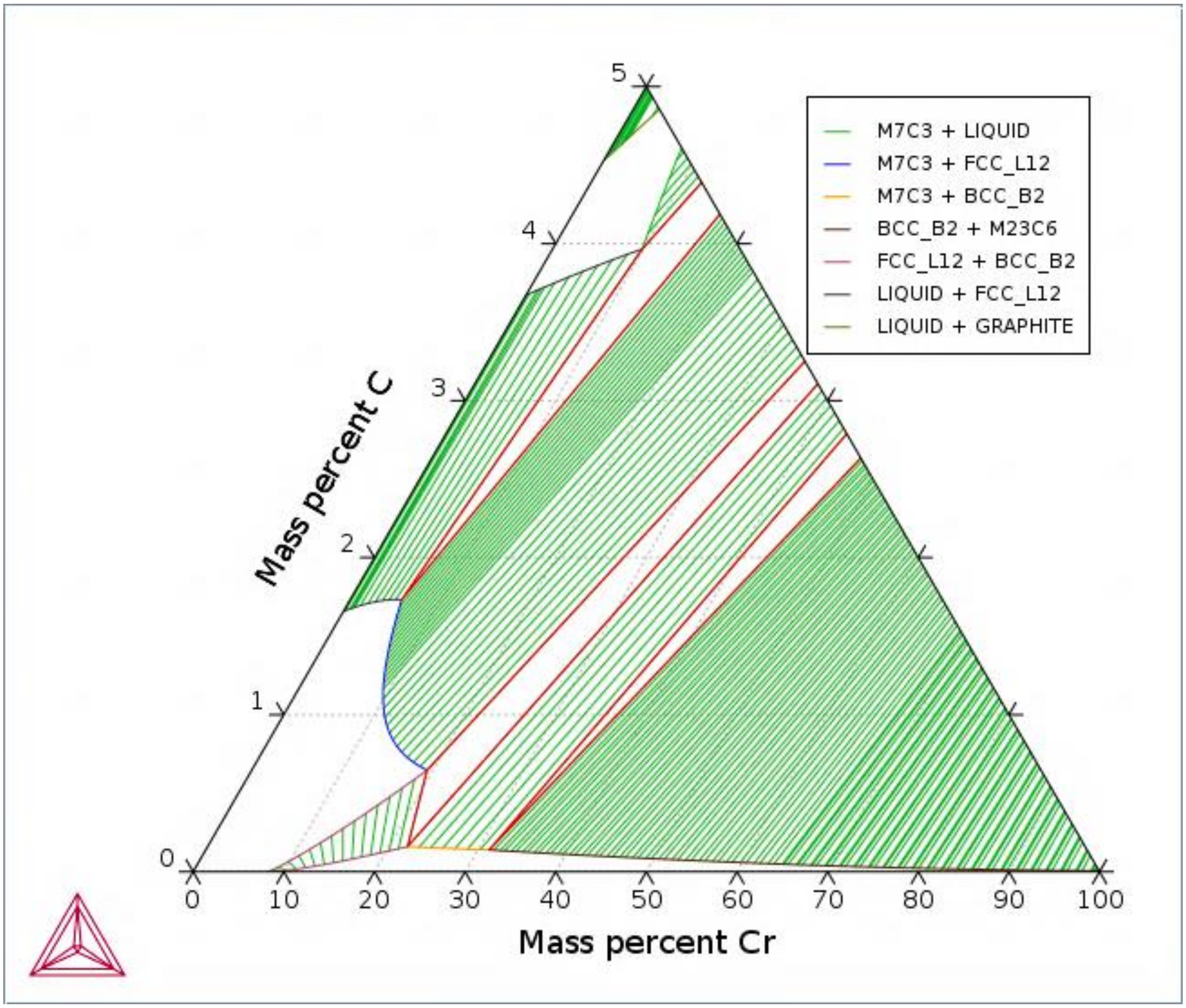


(i) 1350 K : 3.66 wt% C

(ii) 1200 K : 3.20 wt% C

Upon long term exposure to an operating temperature of 1525K, the steel should melt. This is because the carbon content will increase which is expected to decrease the overall melting temperature.

B2.



(i) $\alpha - ferrite$; 84.99Fe-15.0Cr-0.01C

(ii) $\gamma - austenite$; 84.30Fe-15.0Cr-0.70C

(iii) $\alpha - ferrite, \gamma - austenite$; 79.8Fe-20.0Cr-0.20C

$\alpha - ferrite$; 77.3Fe-21.1Cr-1.6C

$\gamma - austenite$; 81.5Fe-18.0Cr-0.5C

(iv) M7C3, $\gamma - austenite$; 82.0Fe-15.0Cr-3.0C

MC73; 47.1Fe-44.2Cr-8.7C

$\gamma - austenite$; 90.2 Fe-8.3Cr-1.5C