Background of Grey Iron Phase Diagram Calculator

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Development:

The phase diagram calculator was developed during a research program sponsored
by
Rassini International, Plymouth MI USA
and
Rassini Frenos, S.A. de C.V., San Martín, Texmelucan, PUEBLA, Mexico.

The research was carried out by the authors at the Univ. Windsor in Ontario Canada.

References:

[1] E. Piwowarsky, "Hochwertiges Gußeisen (Grauguß)," book, Springer Verlag
    2nd edition. 1951.

[2] K. Morschel, Diss. Berlin, 1924, (Reference in [1])

[3] G.I. Sil'man, "Carbon Equivalents of Elements in Cast Iron," Metal Sci. and Heat Treatment
    V44, N1–2, 2002   UDC 669.15-196
    Translated from Metallovedenie i Termicheskaya Obrabotka Metallov, No. 1, pp. 26 – 29,
     January, 2002.

[4] V.E. Bazhenov and M.V. Pikunov, "Determining the Carbon Equivalent of Cast
    Iron by the ThermoCalc Program," published in "Izvestiya VUZ. Chernaya
    Metallurgiya," 2011, No. 11, pp. 20–23.
    and Steel in Translation, 2011, Vol. 41, No. 11, pp. 896–899.

From the phase diagrams of Fe-C-Si system with different levels of Si described in the literature, primarily from Piwowarsky's book, one can create a 3D image of all the lines available. The points on the phase lines are not at any fixed intervals so one needs to interpolate along each line to create equal interval points.
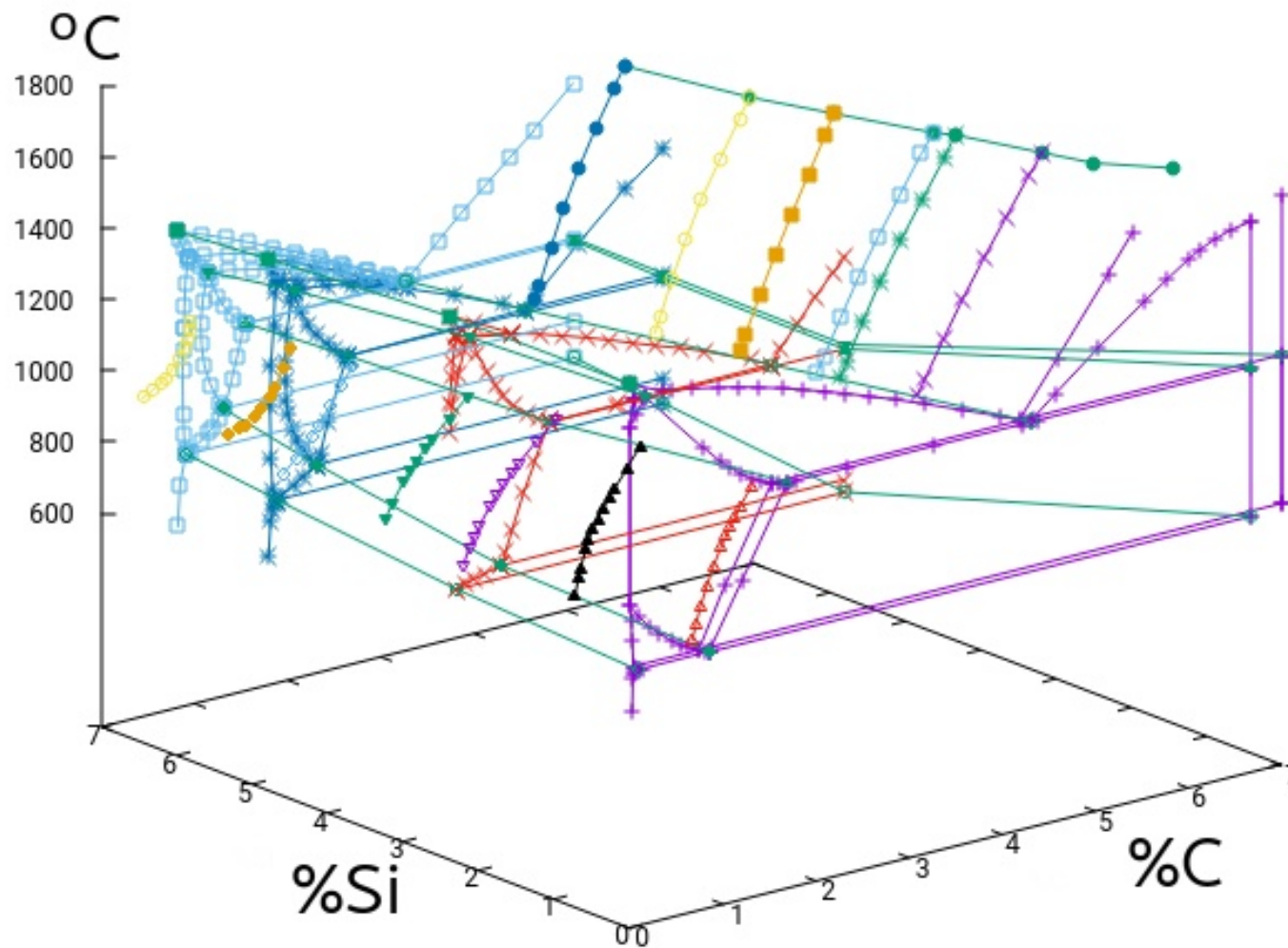

Fig. 1 A 3D plot showing the raw Fe-C-Si phase diagram data points from compiled information of various sources.

The lines used in the phase diagram calculator after interpolation along each line to create equal length line segments. Other phase lines are available but not used for grey cast iron.
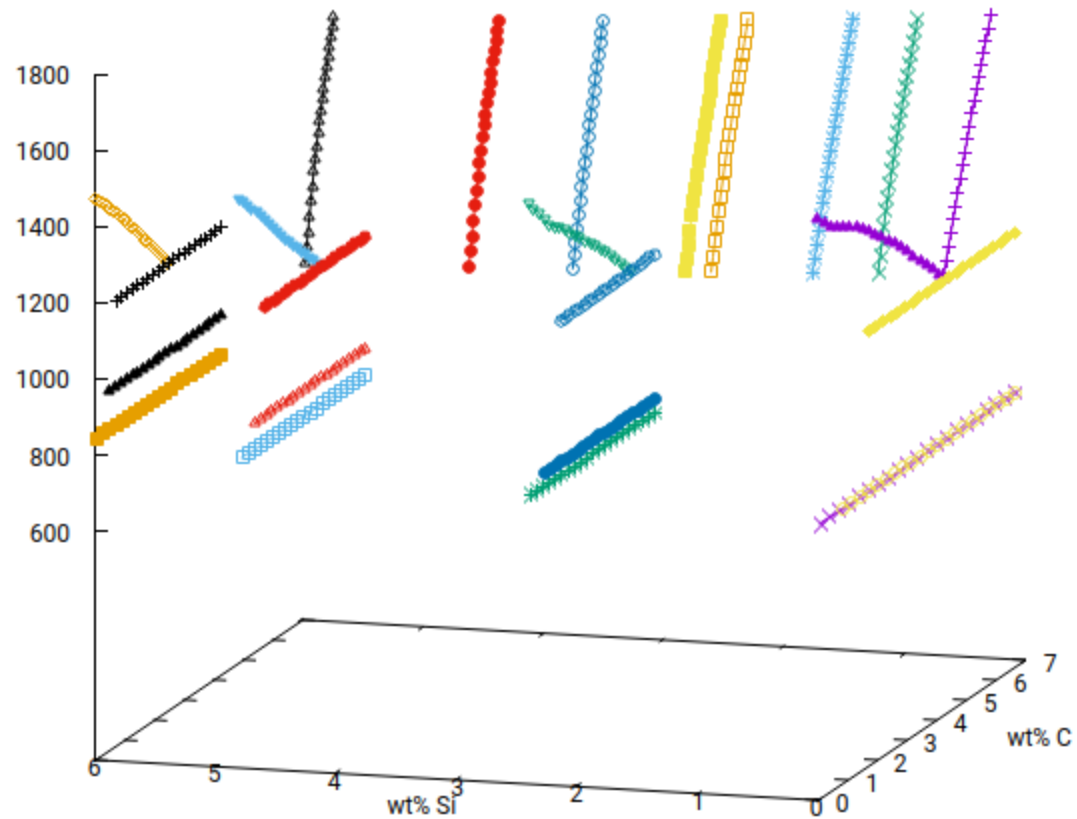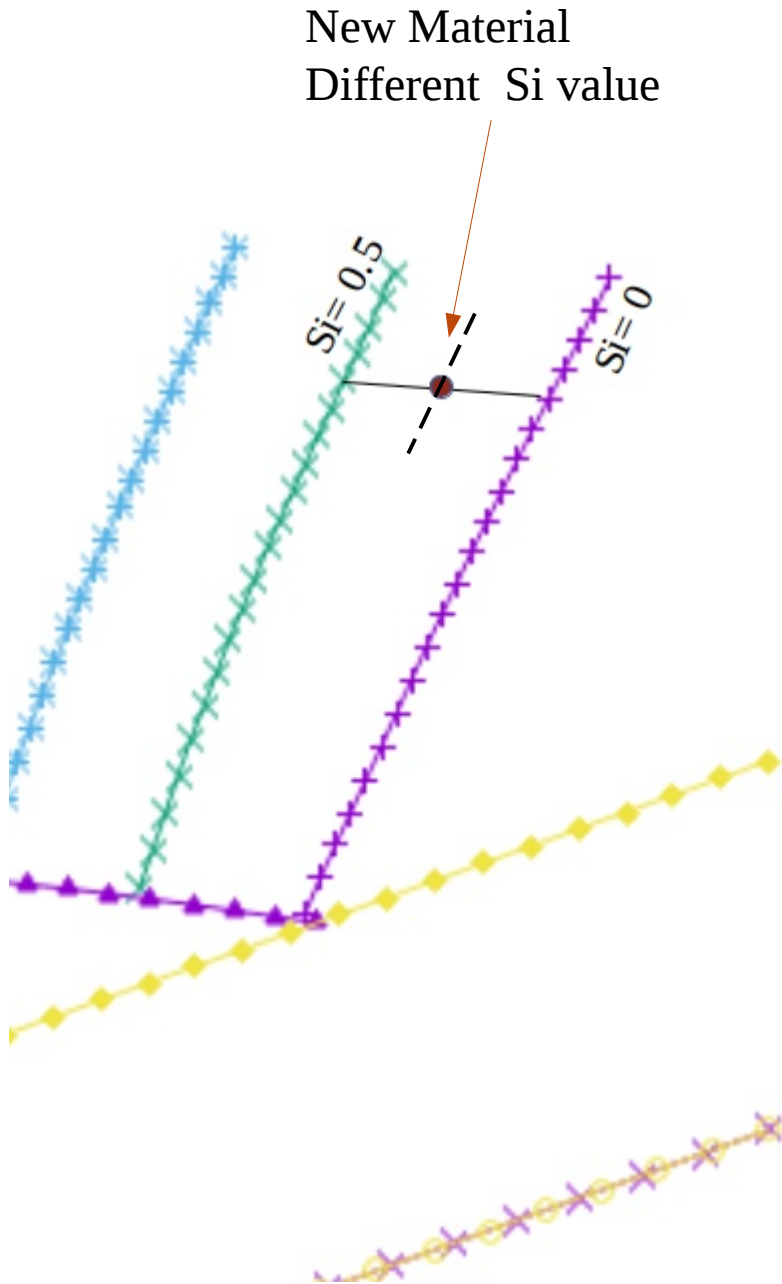

Fig. 2   Phase lines from literature used to generate the phase diagrams in the calculation program.

New Material
Different Si value

Si= 0.5

Si = 0

The raw data points that define each phase diagram lines are interpolated to yield equal numbers of, in this case 20, line segments.

On any given line each line segment is of the same length. Thus for a material with an Si value not directly available on a line, one can interpolate for a new set of points that approximate the phase line of the desired Si value.   (Dashed line in figure)

A phase diagram can therefore be created for any value of Si between the limits of 0 to 5% Si, shown in Fig. 1. For values of 6% and 7%Si not all of the phase lines are available.

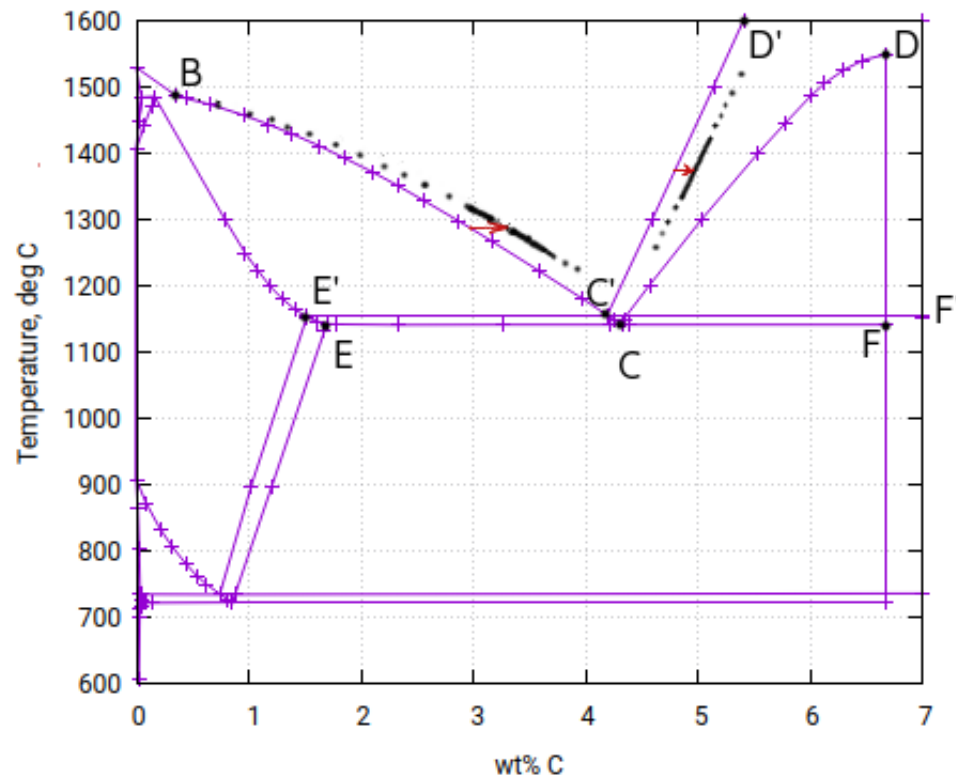Fig.3 Interpolating between known Si % phase lines

On the calculator web page the chemistry needs to be entered in several text boxes. The user can replace the default values.

1. Enter:

#Material Name=×

#Chemistry:

#C= 3.7	#Si= 2.12	#Al= 0	
#Cu= 0	#Ni= 0	#Co= 0	#Mn= 0
#Mo= 0	#Cr= 0	#V= 0	#Ti= 0
#P= 0	#S= 0.03		

In the calculator the effect of elements added, other than Fe-C-Si, are shown as translations of the C'-B, the C'-D' and the E'-F'   phase lines as computed by rules developed by
    Silman [3] and
    Bazhenov [4]

The amount of translation is based on the Carbon Equivalent (Ceq) computed by either Silman of Bazhenov. Ceq moves the C' or C point and the three lines move with it.

The C'-D' line is translated in parallel to the original, while the C'-B line is rotated about the B point.

The interpolated phase diagram lines for the Fe-C-Si system are plotted by the calculator in black with the Si=0 phase diagram shown in light green as background.   For the other elements red lines are show using the Cequiv computed with Silman's [3] method and blue lines are depicted using the Cequiv according to the Bazhenov and Pikunov [4] scheme.

The calculator also prints out the co-efficients and equivalents from the methods of ref. [3] and [4].

For explanation of calculator usage:
 https://fde.uwaterloo.ca/PhaseDG/howto-A.pdf