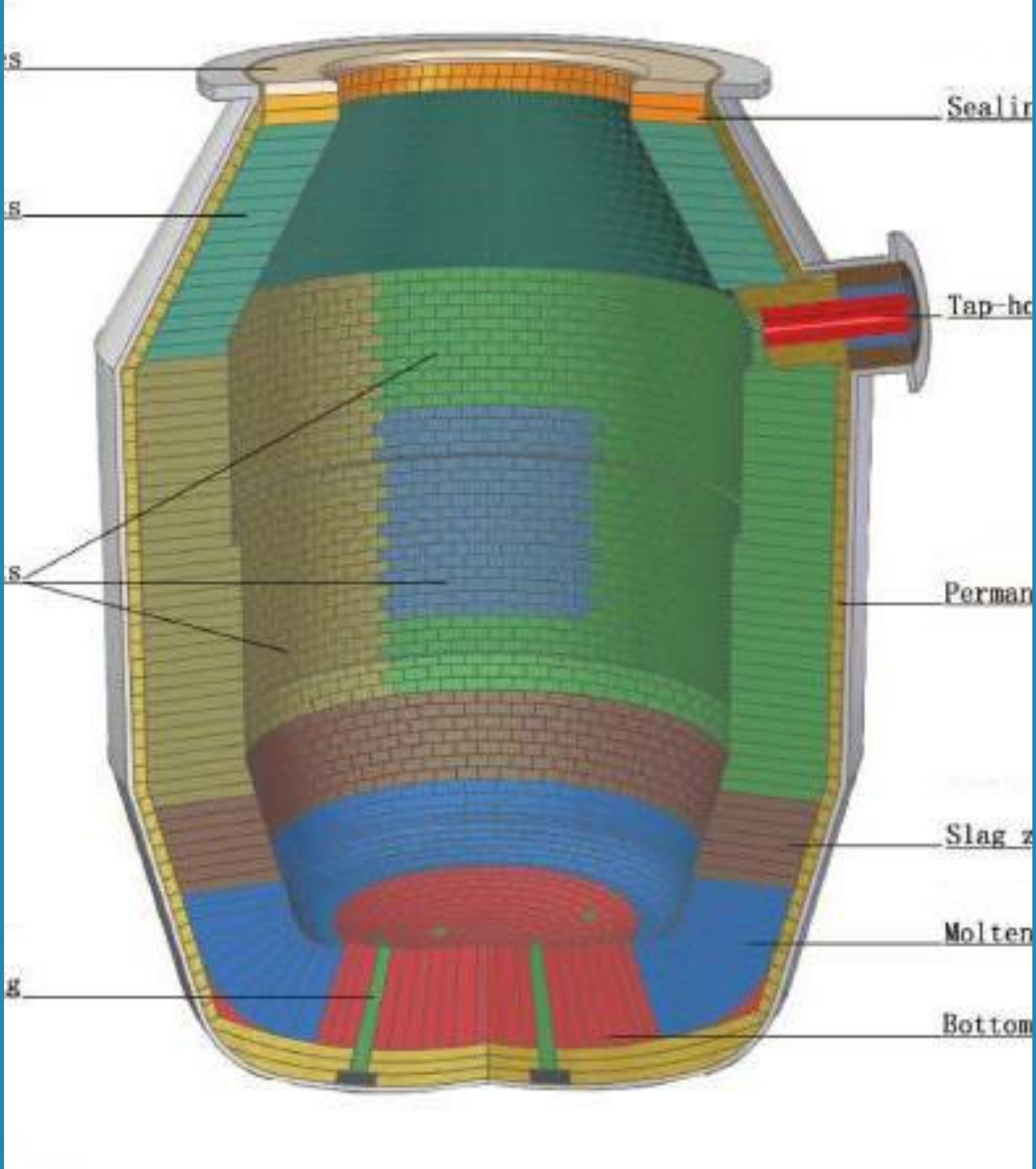


Basic Oxygen Furnace (Primary Steel Making)

MSE497A (UGP III)

Supervisor: Dr. Rahul Sarkar

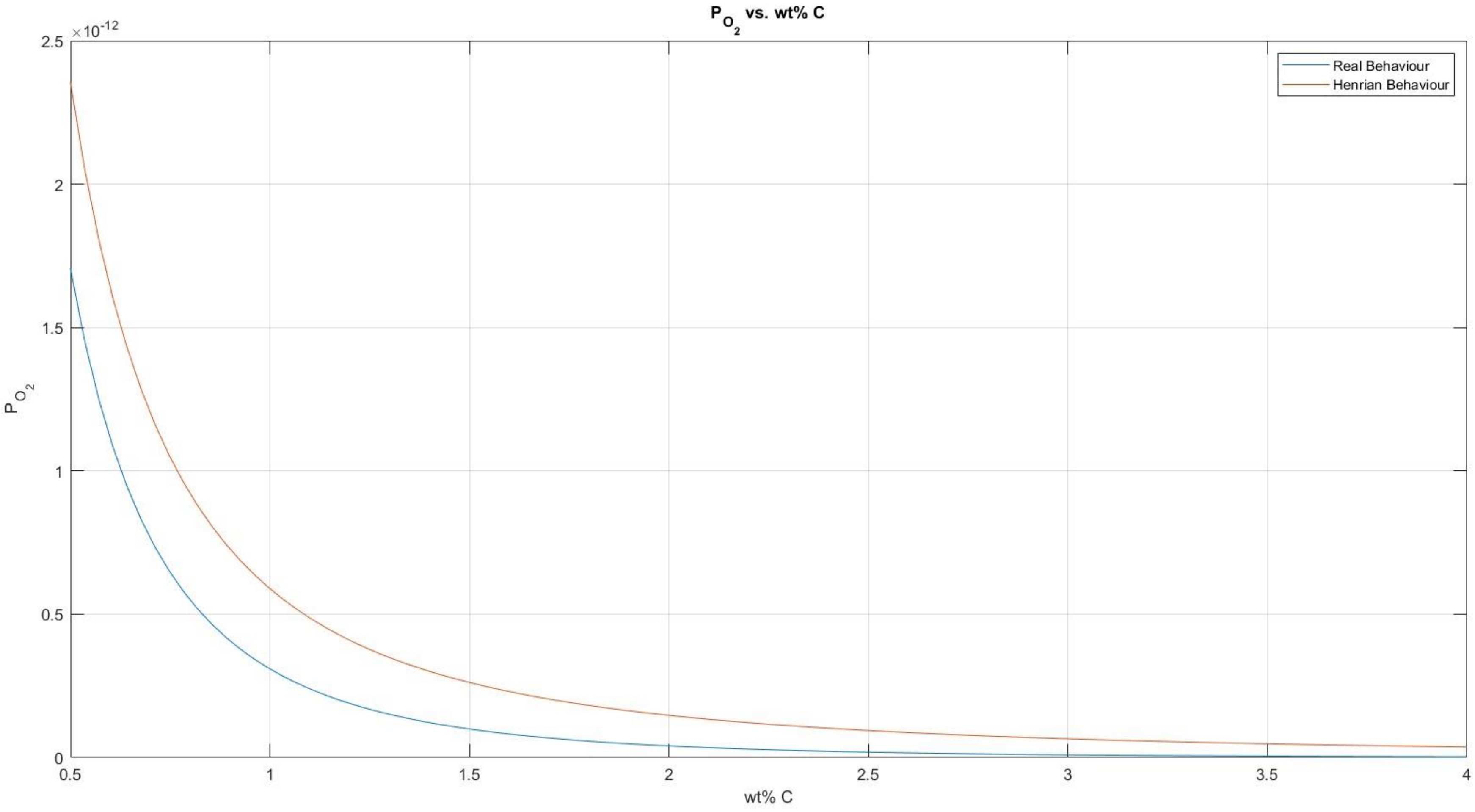
Rishi Verma

WEEK – 1 WORK

Iron – Carbon Alloy

- $Fe\ - 4\%\ C\ alloy, T = 1600^{o}C$
- $Carbon\ varies\ from\ (4.0\ - 0.5\ wt\%)$
- $P_{CO} = 1\ atm, P_T = 1\ atm$
- *Total pressure is 1 atm means in gas phase only carbon monoxide is present.*
- $C_{(1\ wt\%\ in\ liquid\ Fe)} + \frac{1}{2}O_2(g) = CO(g)$
- *For the above reaction deltaG^{o} at temperature T will be:*
- $\Delta G^{o} = -134{,}300 - 45.39T\ \frac{J}{mol}$

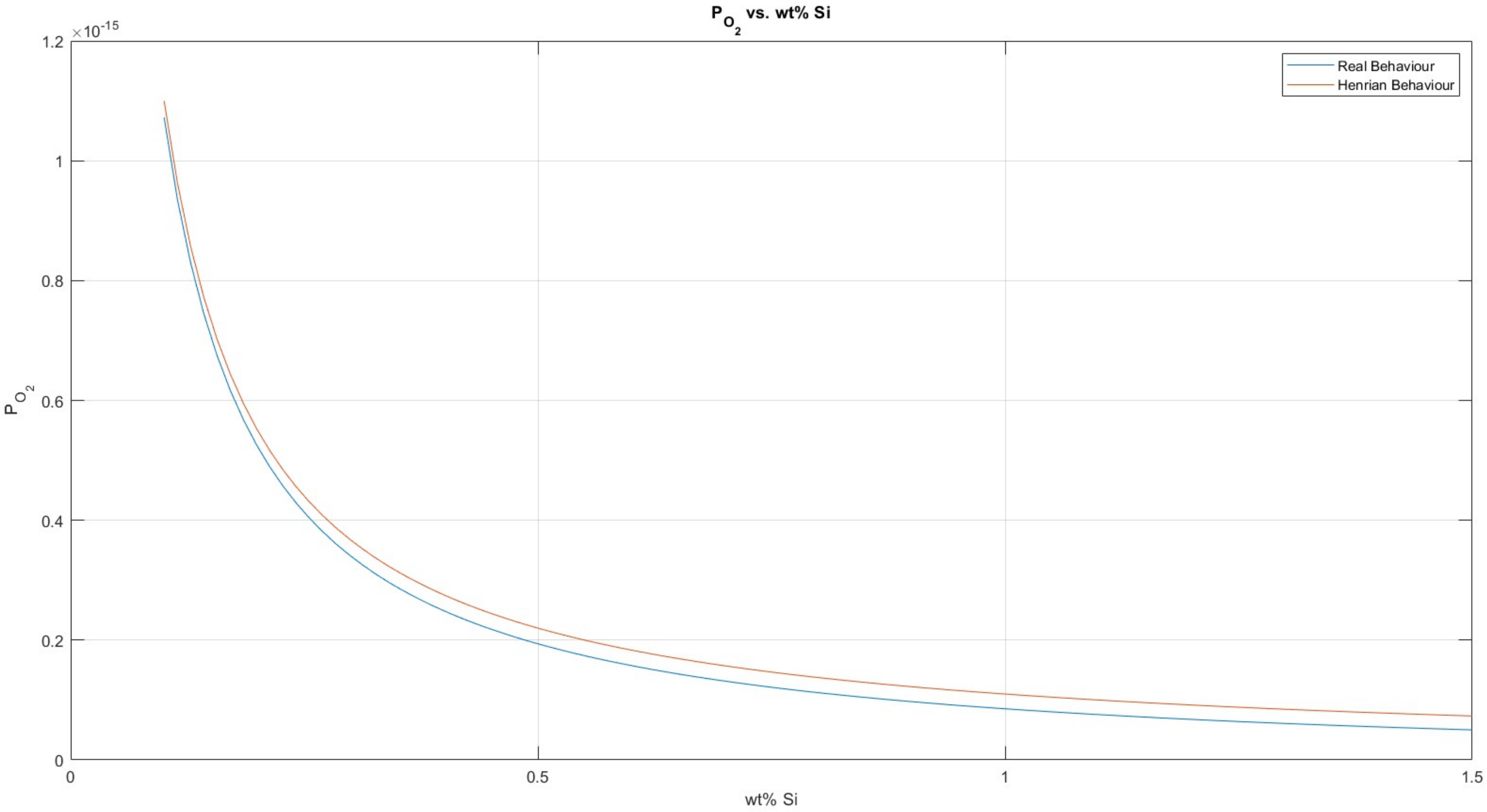
Graph of P_{O_2} vs wt% C



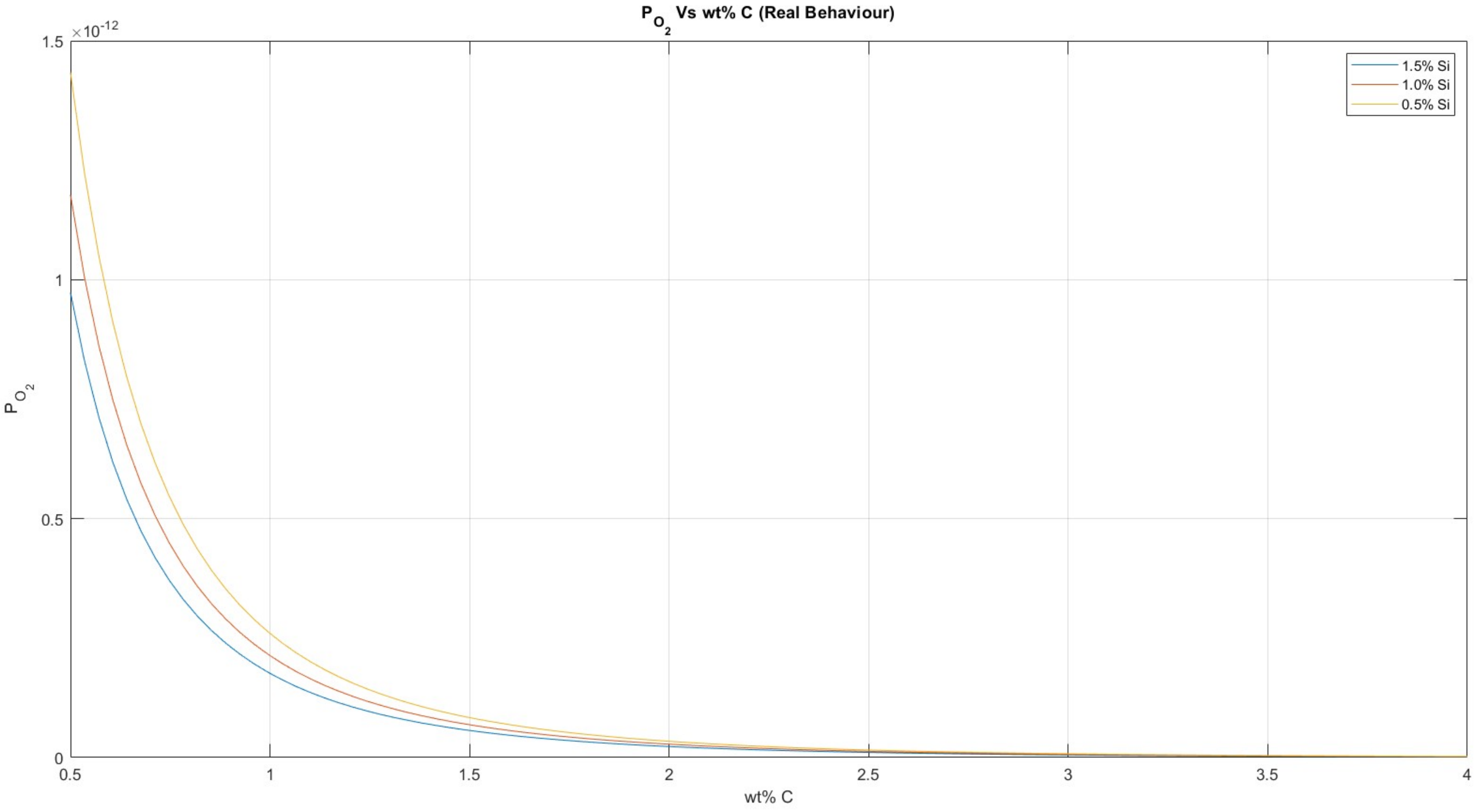
Silicon – Carbon Alloy

- $Fe\ -1.5\%\ Si\ alloy, T = 1600^{o} C$
- $Silicon\ varies\ from\ (1.5\ - 0.1\ wt\%)$
- $a_{SiO_2} = 1$
- $\{Si\} + (O_2) = \langle SiO_2 \rangle$
- *For the above reaction deltaG° at temperature T will be:*
- $\Delta G^{o} = -952{,}500 + 202.8T \frac{J}{mol}$

Graph of P_{O_2} vs wt% Si

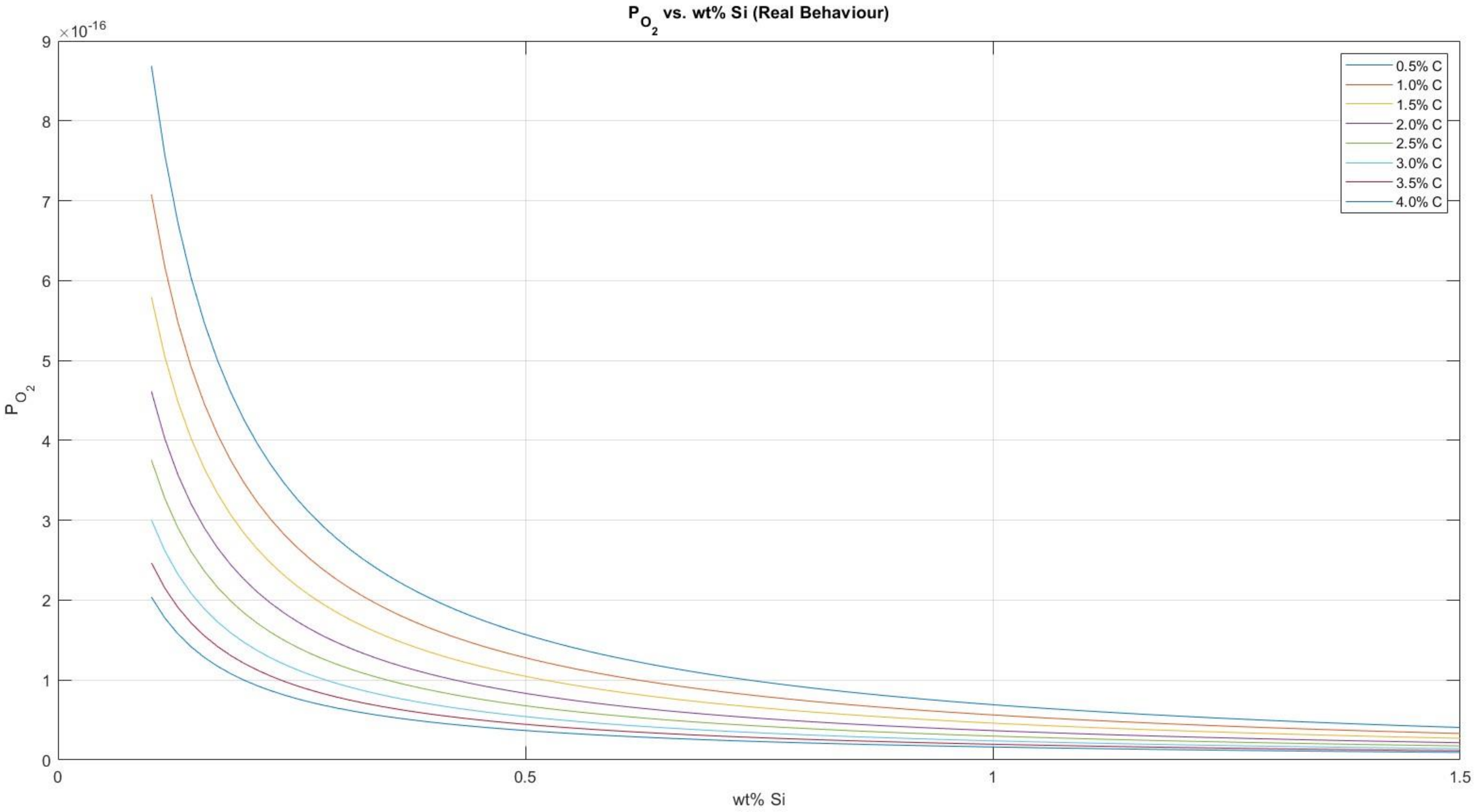


Carbon in Carbon – Silicon – Iron Alloy



- In above slide, there is a graph of carbon in Carbon-Silicon-Iron alloy.
- For this graph firstly I plotted the graph of P_{O_2} $vs\ wt\%\ C$ by fixing the $wt\%\ Si = 1.5\%$
- Then I plotted for $wt\%\ Si = 1.0\%\ and\ for\ 0.5\%$
- And for Silicon in Carbon-Silicon-Iron Alloy, I plotted the graph of P_{O_2} $vs\ wt\%\ Si$ by fixing the $wt\%\ C = 4.0\%$
- Then I plotted for $wt\%\ C = 3.5\%$, 3.0% , 2.5% , 2.0% , 1.5% , 1.0% and for 0.5%

Silicon in Carbon – Silicon – Iron Alloy



WEEK – 2 & 3 WORK

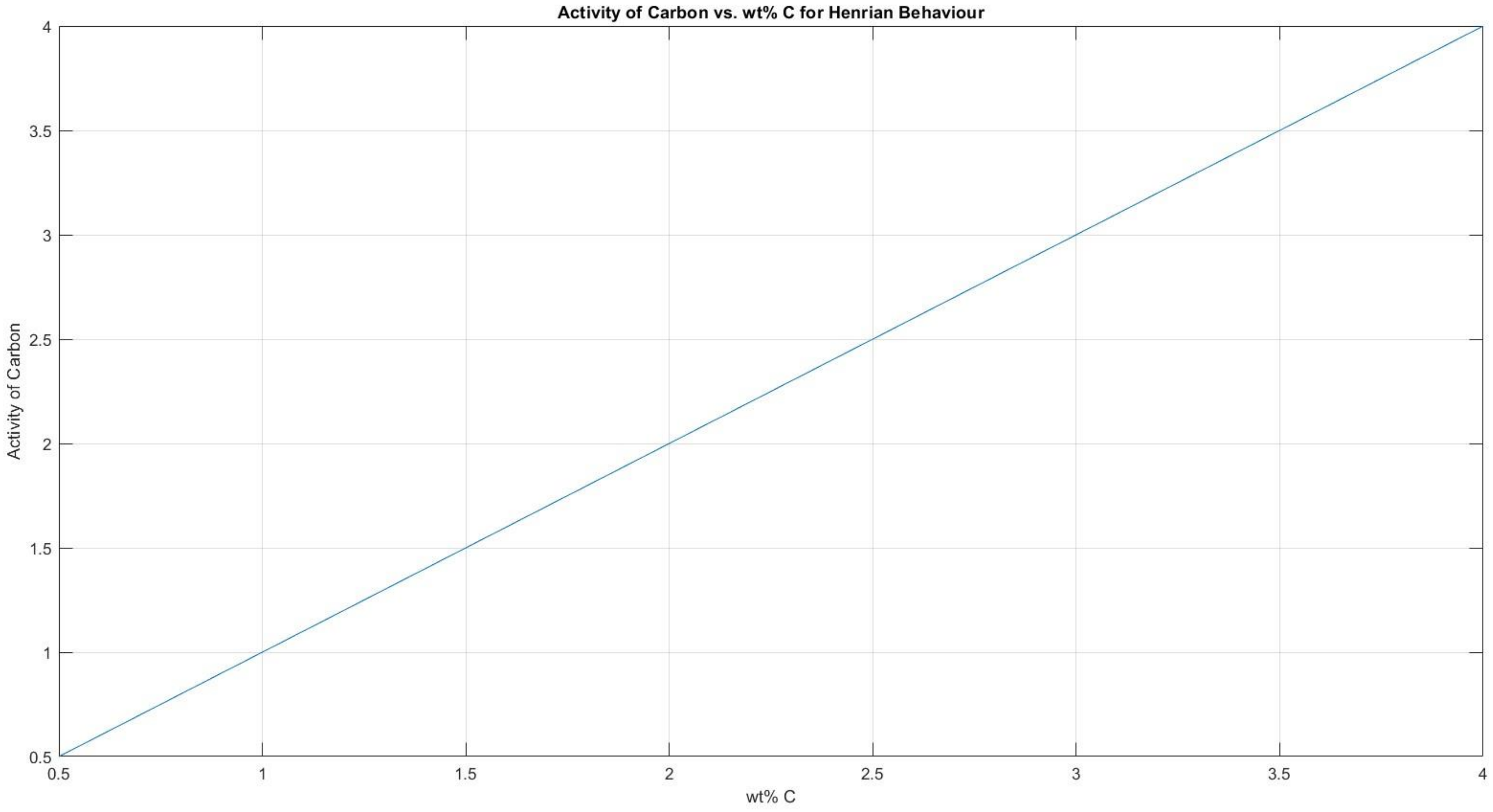
Iron – Carbon Alloy

- $Fe\ -4\%\ C\ alloy, T = 1600^o C$
- $Carbon\ varies\ from\ (4.0\ - 0.5\ wt\%)$
- $P_{CO} = 1\ atm, P_T = 1\ atm$
- *Total pressure is 1 atm means in gas phase only carbon monoxide is present.*
- $C_{(1\ wt\%\ in\ liquid\ Fe)} + \frac{1}{2}O_2(g) = CO(g)$
- *For the above reaction deltaG^o at temperature T will be:*
- $\Delta G^o = -134{,}300 - 45.39T\ \frac{J}{mol}$

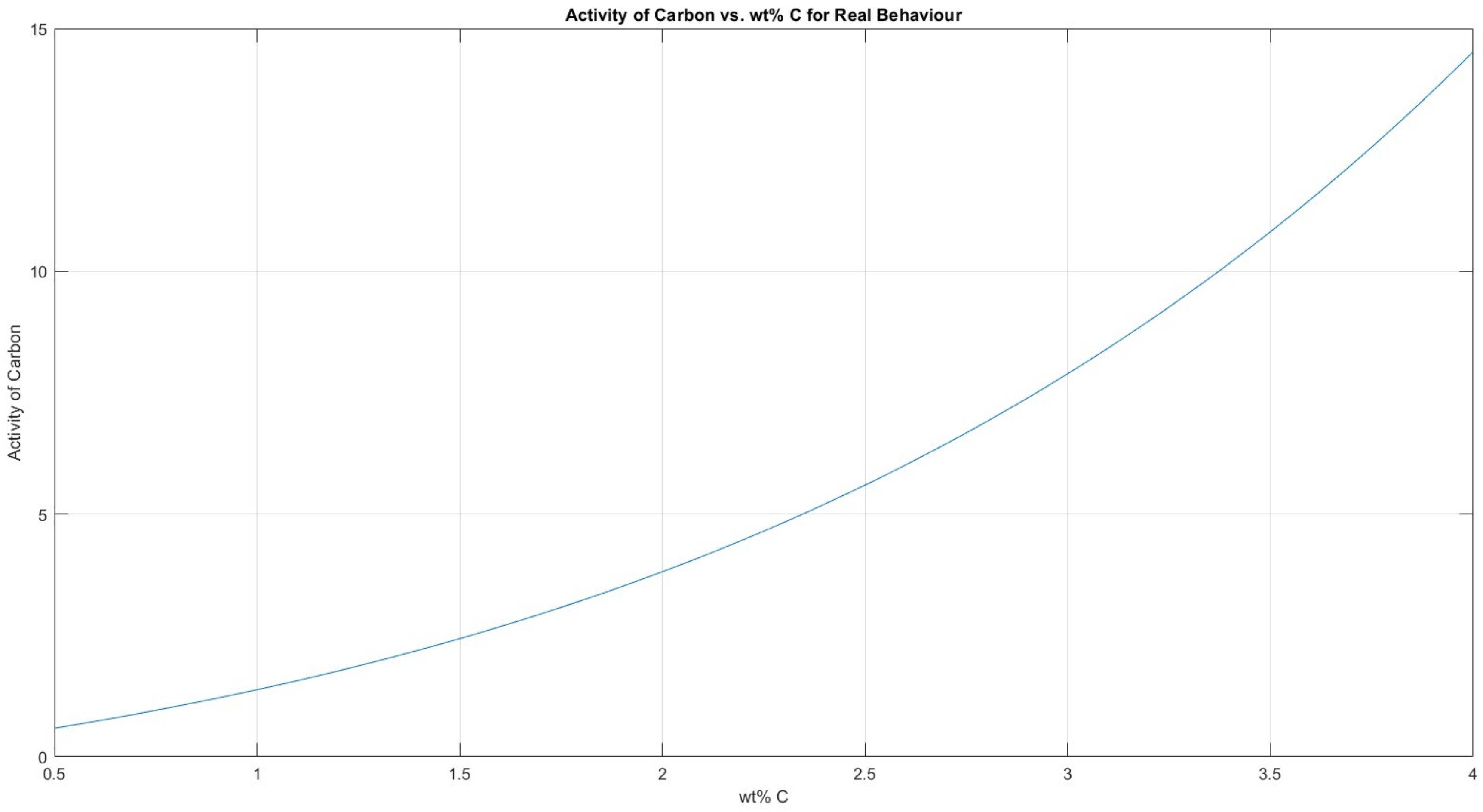
Activity of Carbon in Iron – Carbon Alloy

- $a_c = f_c.(wt\% \, C)$
- When Henrian Law obey then $f_c = 1.$
- Therefore, $a_c = wt\% \, C$
- When Henrian Law doesn't obey then
- $log(f_c) = e_c^c.(wt\% \, C)$
- $e_c^c = 0.14$
- Therefore, $a_c = 10^{e_c^c.(wt\% \, C)}.(wt\% \, C)$

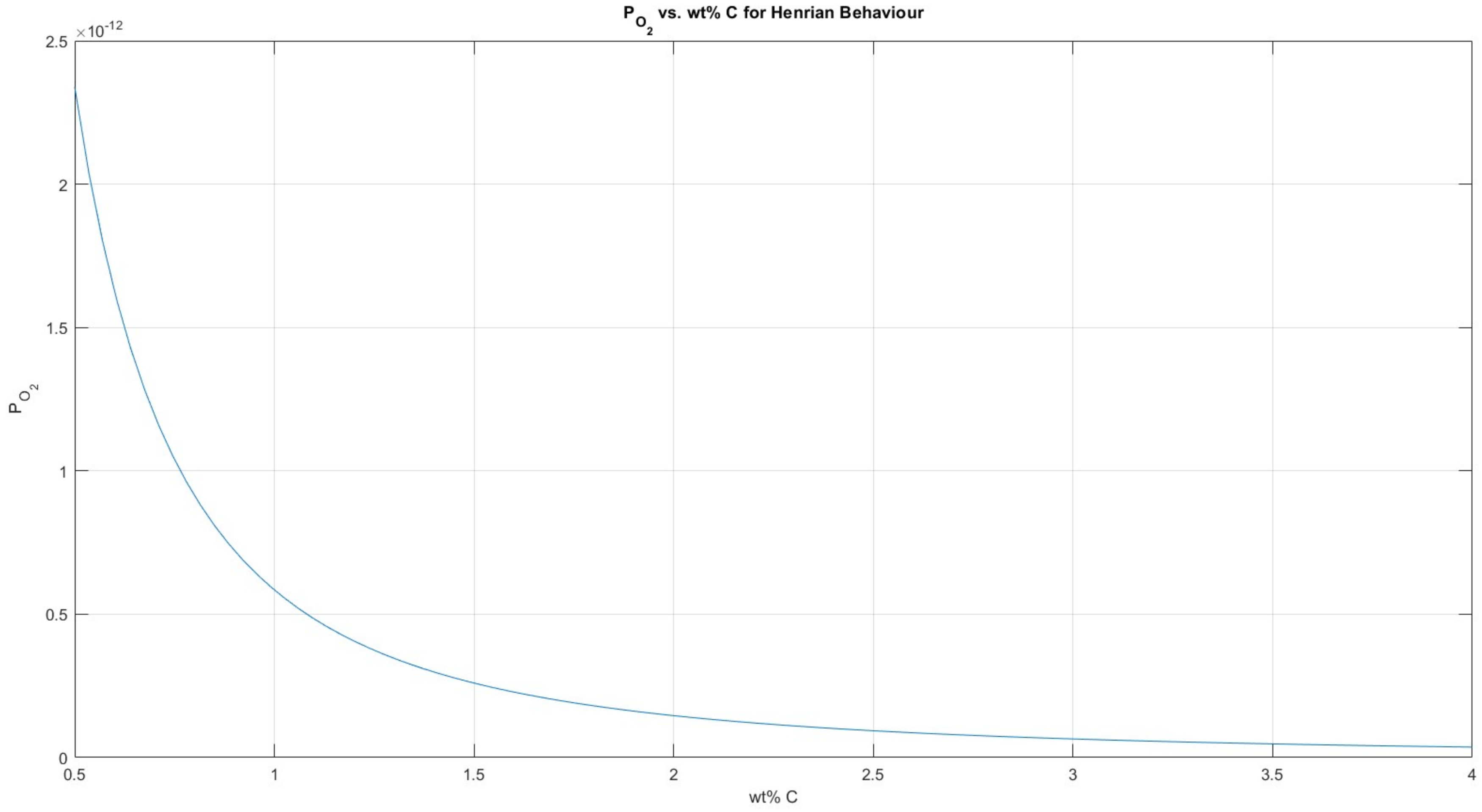
Graph of Activity of Carbon (Henrian Behavior)



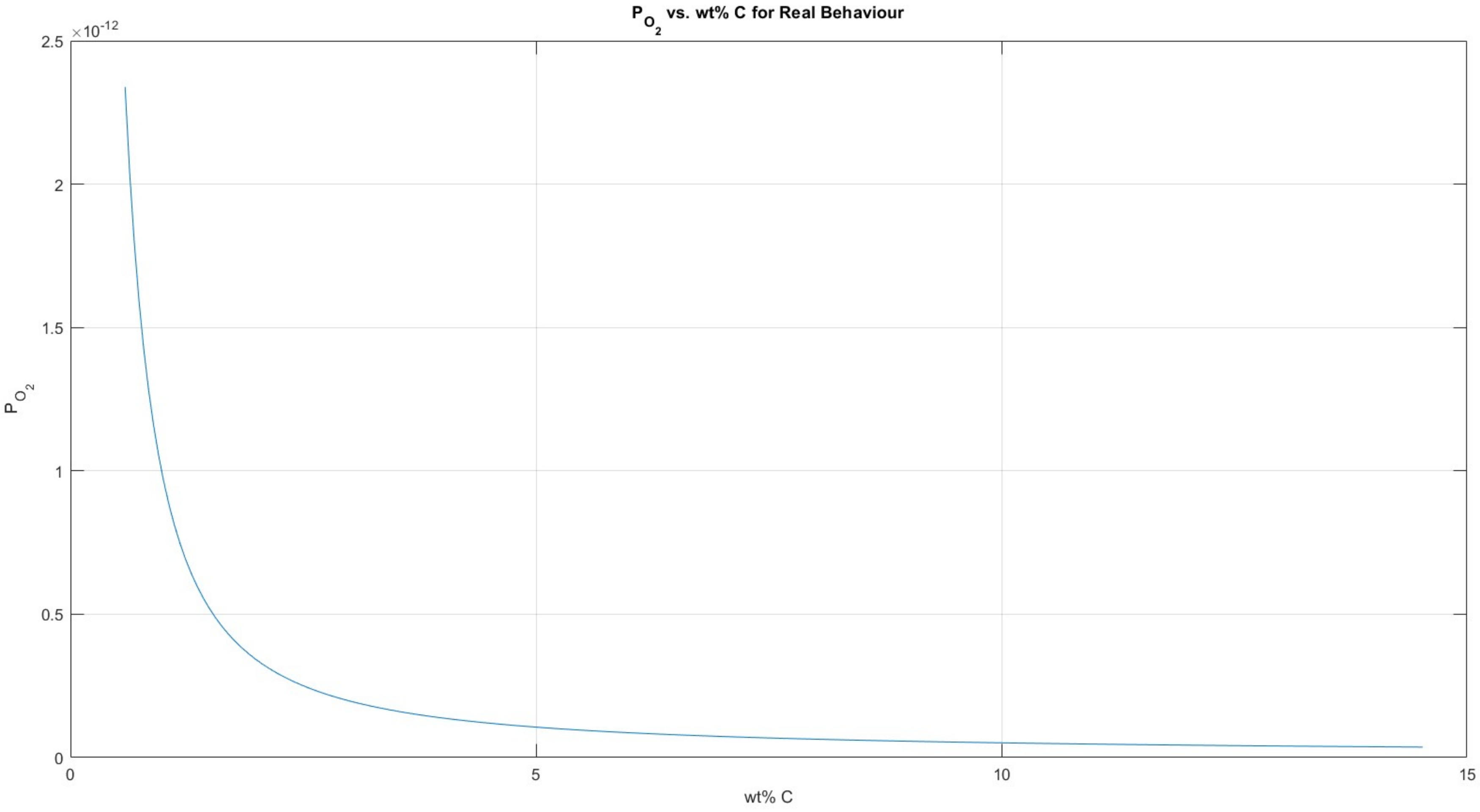
Graph of Activity of Carbon (Real Behavior)



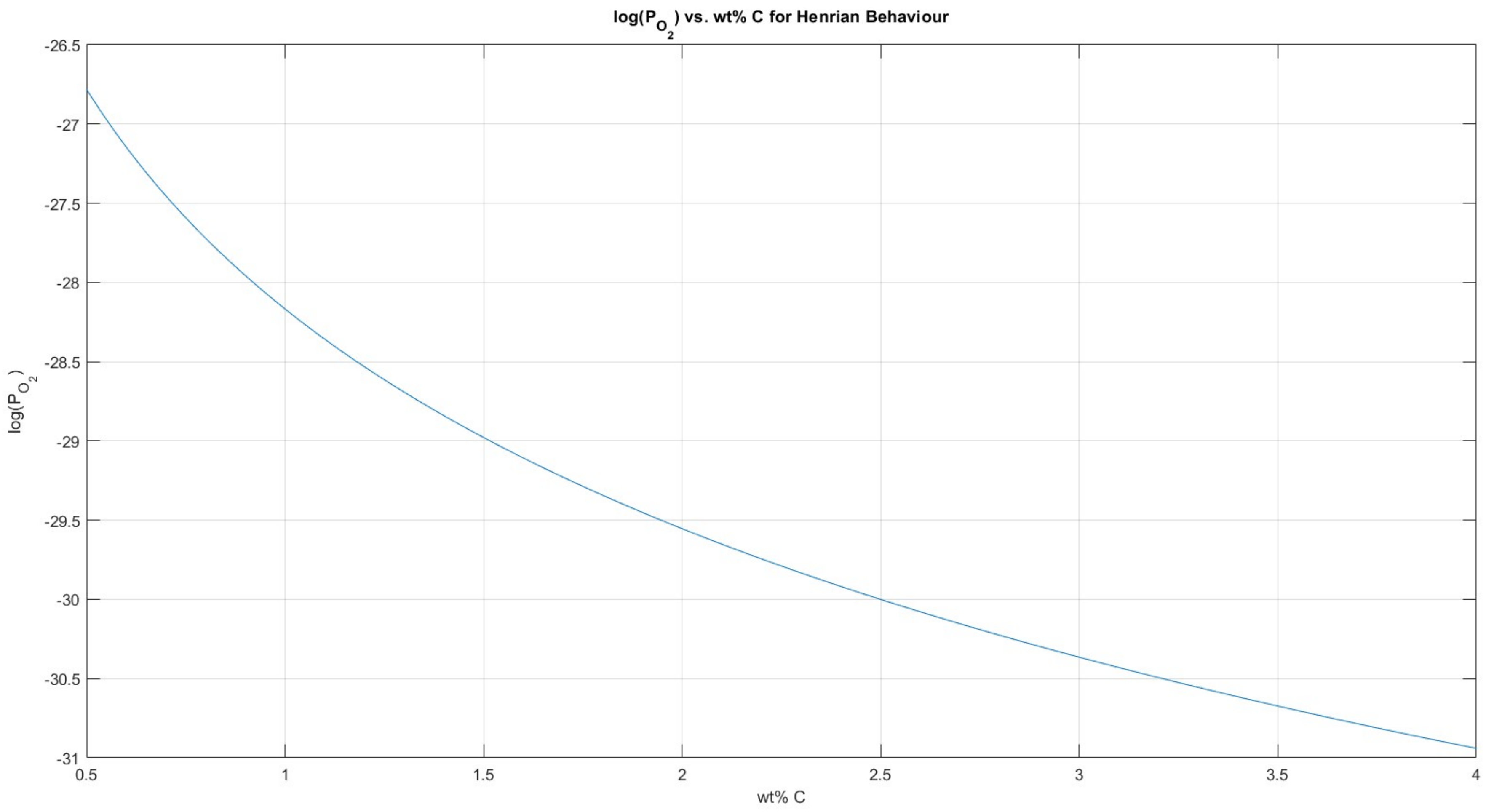
Graph of $P_{O_2} vs\ wt\%\ C$ (Henrian behavior)



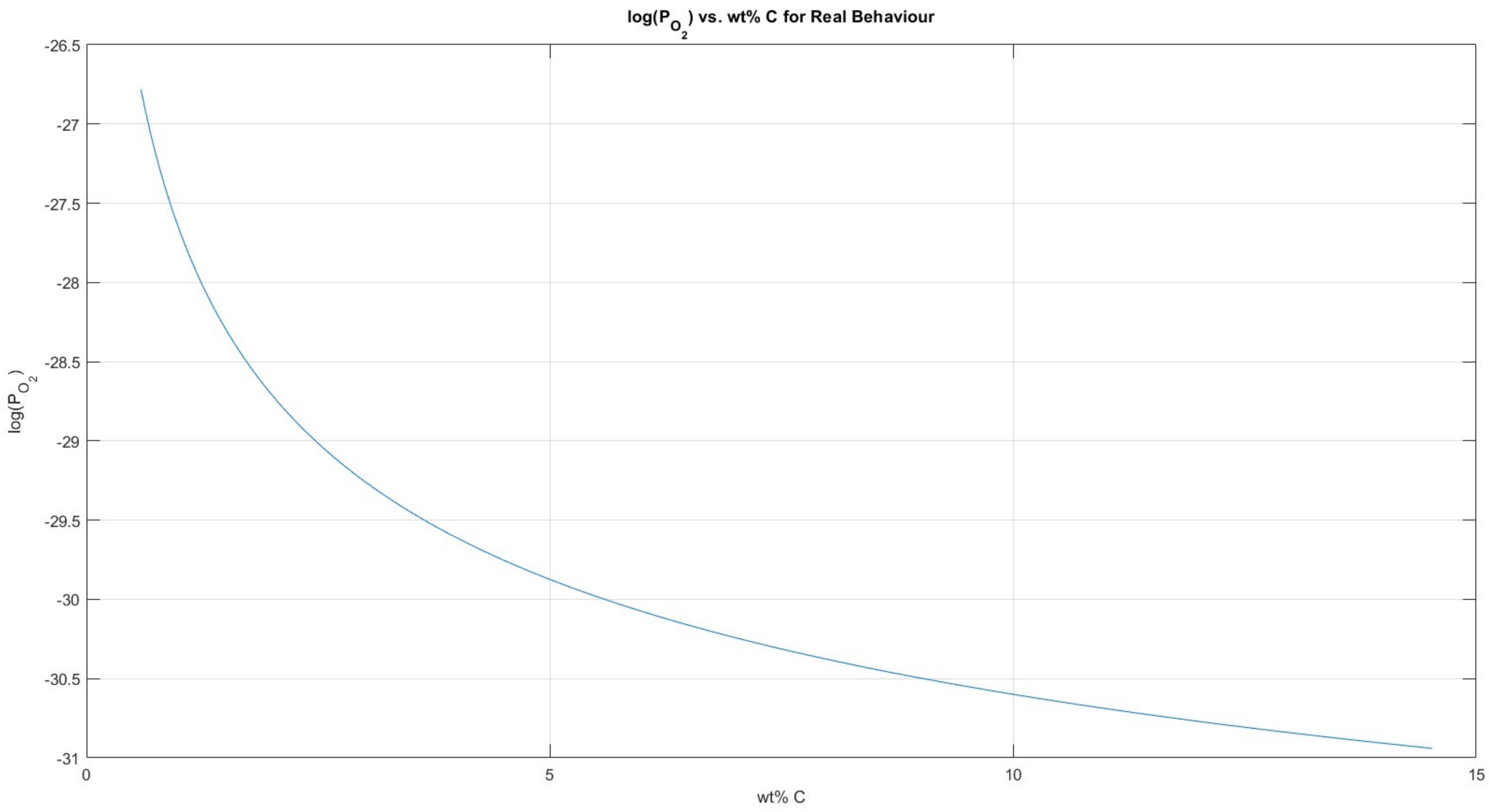
Graph of $P_{O_2} vs\ wt\%\ C$ (Real behavior)



Graph of $ln(P_{O_2}) vs\ wt\%\ C$ (Henrian behavior)



Graph of $ln(P_{O_2}) vs\ wt\%\ C$ (Real behavior)



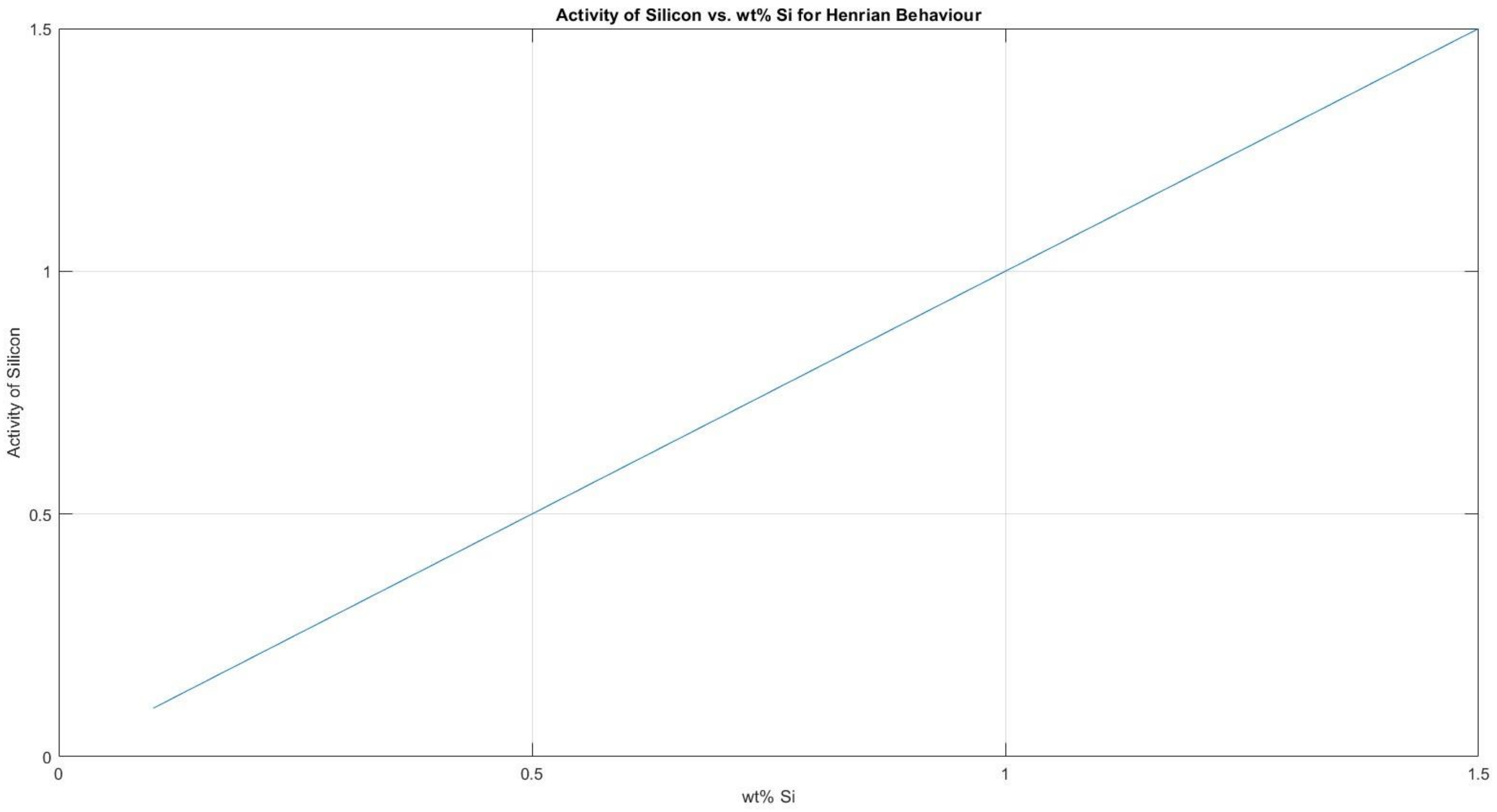
Silicon – Carbon Alloy

- $Fe\ - 1.5\%\ Si\ alloy, T = 1600^{o}C$
- $Silicon\ varies\ from\ (1.5\ - 0.1\ wt\%)$
- $a_{SiO_2} = 1$
- $\{Si\} + (O_2) = \langle SiO_2 \rangle$
- *For the above reaction deltaG^o^ at temperature T will be:*
- $\Delta G^{o} = -952{,}500 + 202.8T\,\frac{J}{mol}$

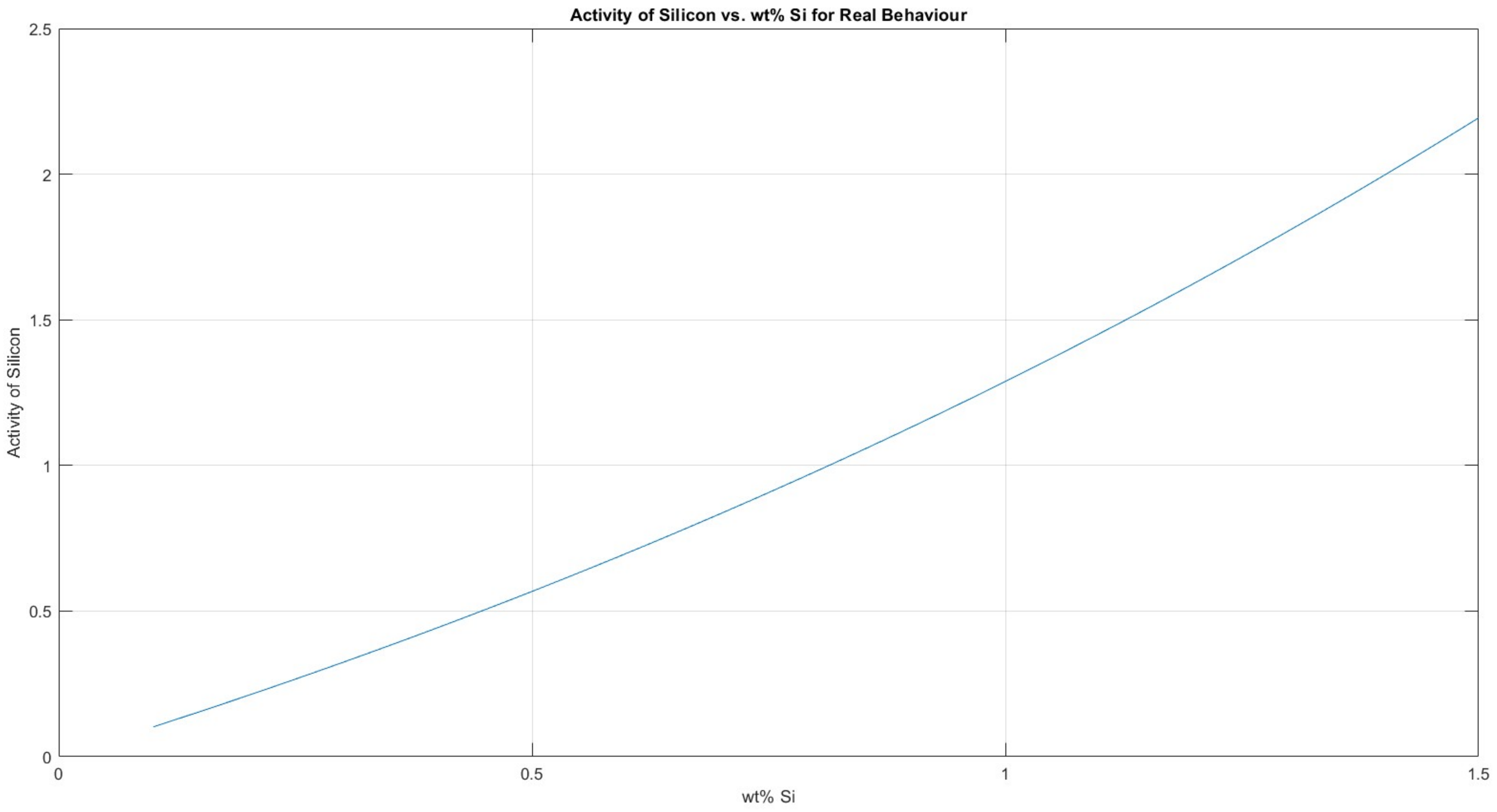
Activity of Silicon in Iron – Silicon Alloy

- $a_{Si} = f_{Si}.(wt\% \, Si)$
- When Henrian Law obey then $f_{Si} = 1.$
- Therefore, $a_{Si} = wt\% \, Si$
- When Henrian Law doesn’t obey then
- $log(f_{Si}) = e_{Si}^{Si}.(wt\% \, Si)$
- $e_{SI}^{Si} = 0.11$
- Therefore, $a_{Si} = 10^{e_{Si}^{Si}.(wt\% \, Si)}.(wt\% \, Si)$

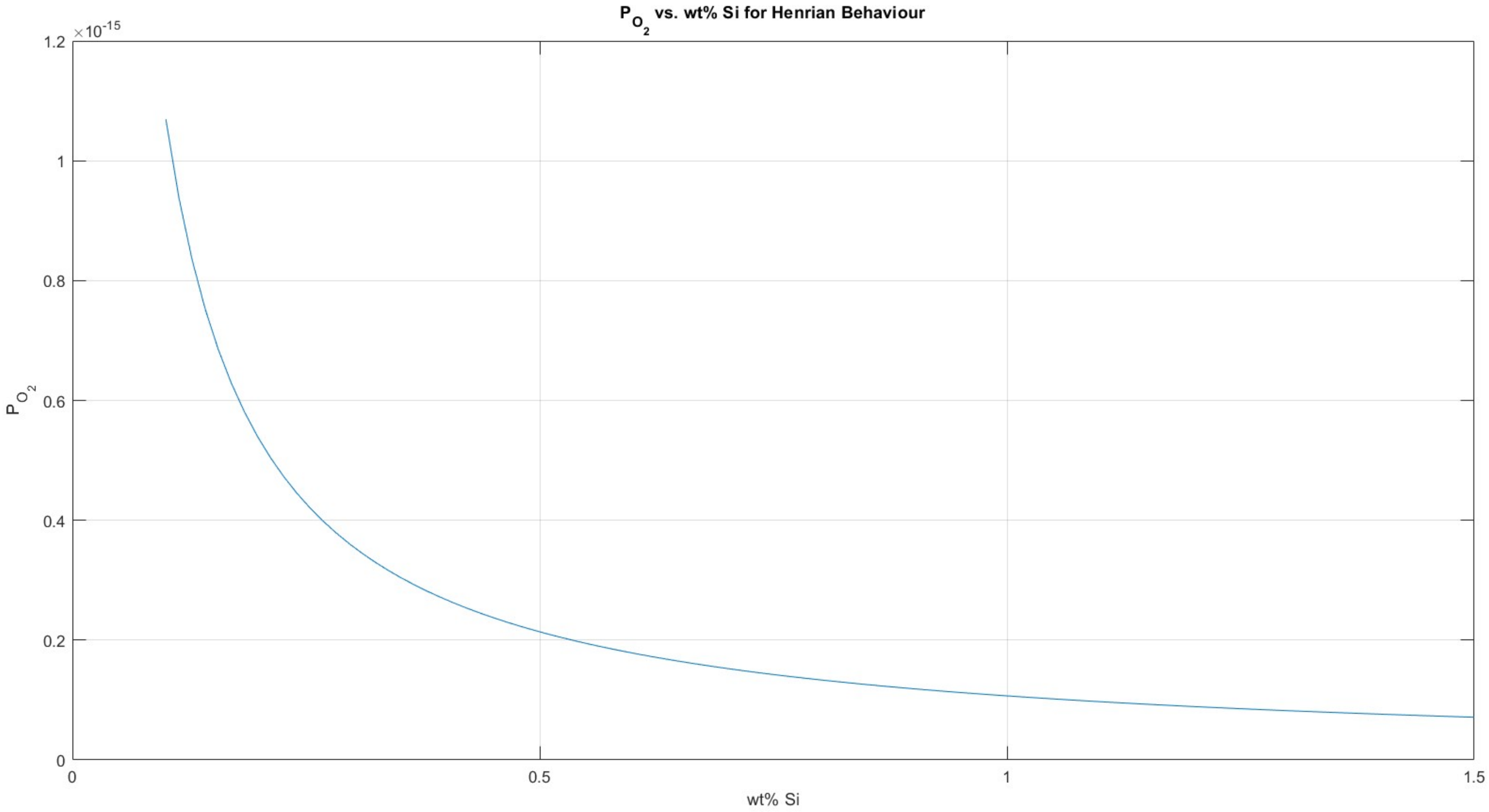
Graph of Activity of Silicon (Henrian Behavior)



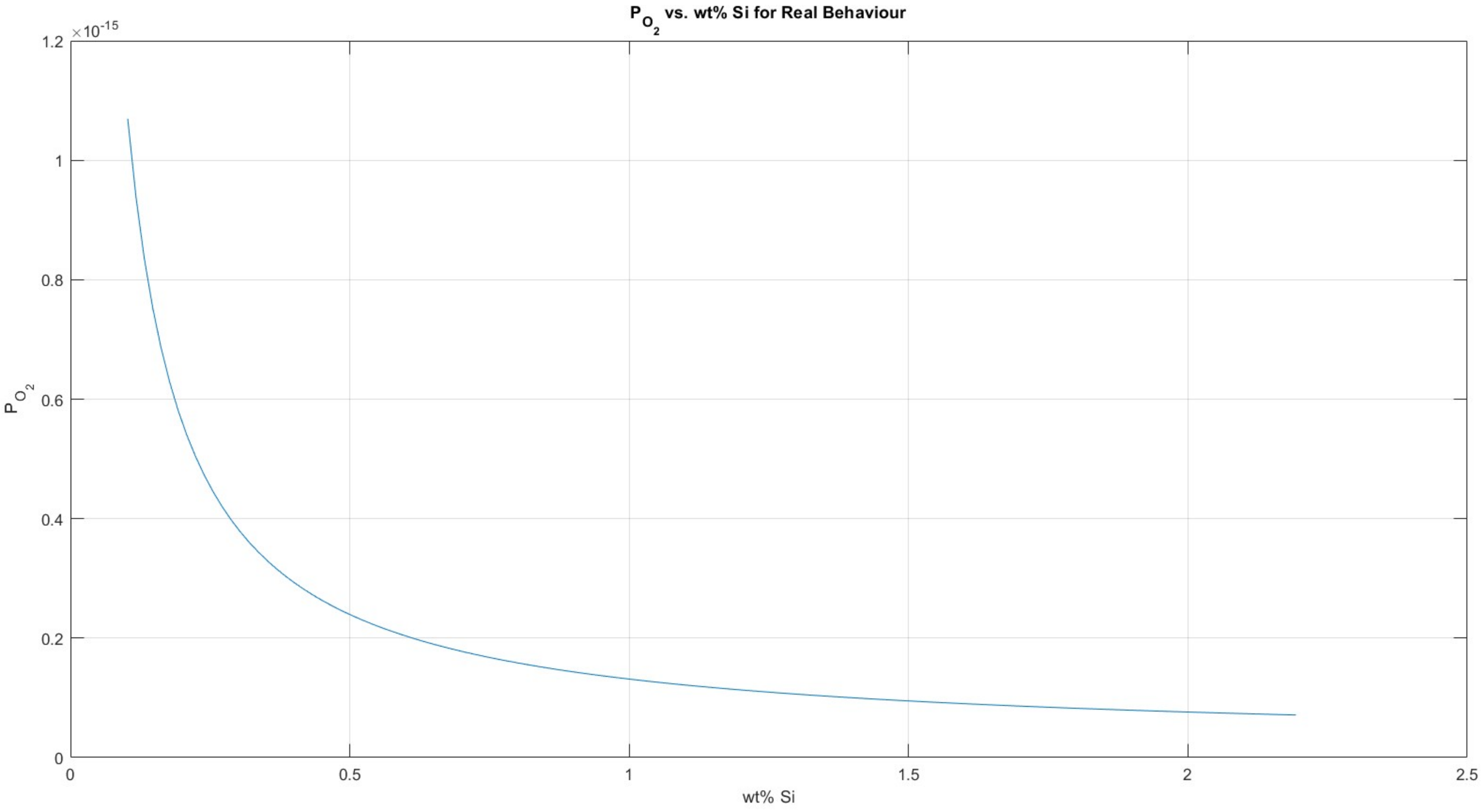
Graph of Activity of Silicon (Real Behavior)



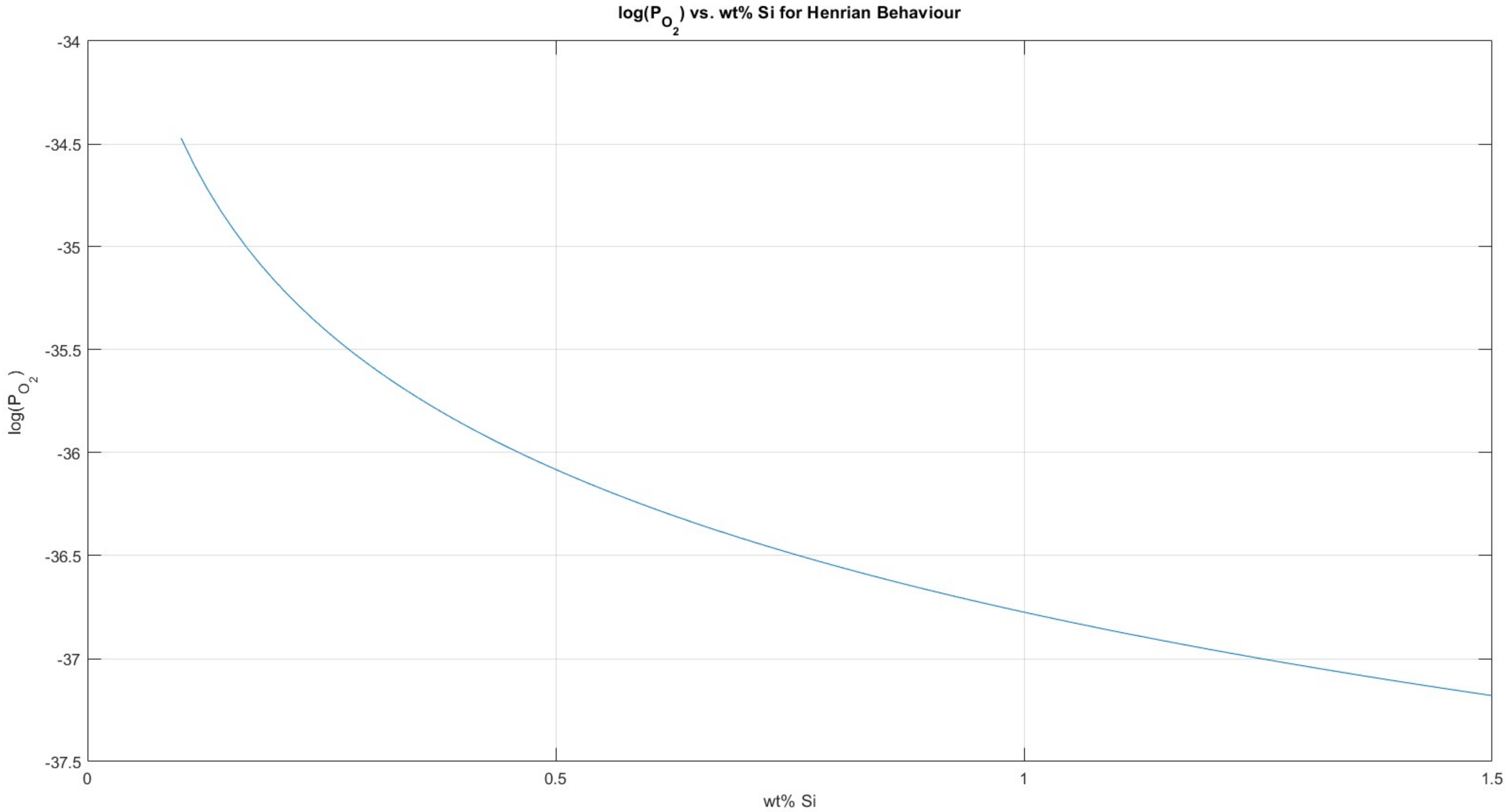
Graph of $P_{O_2} vs\ wt\%\ Si$ (Henrian behavior)



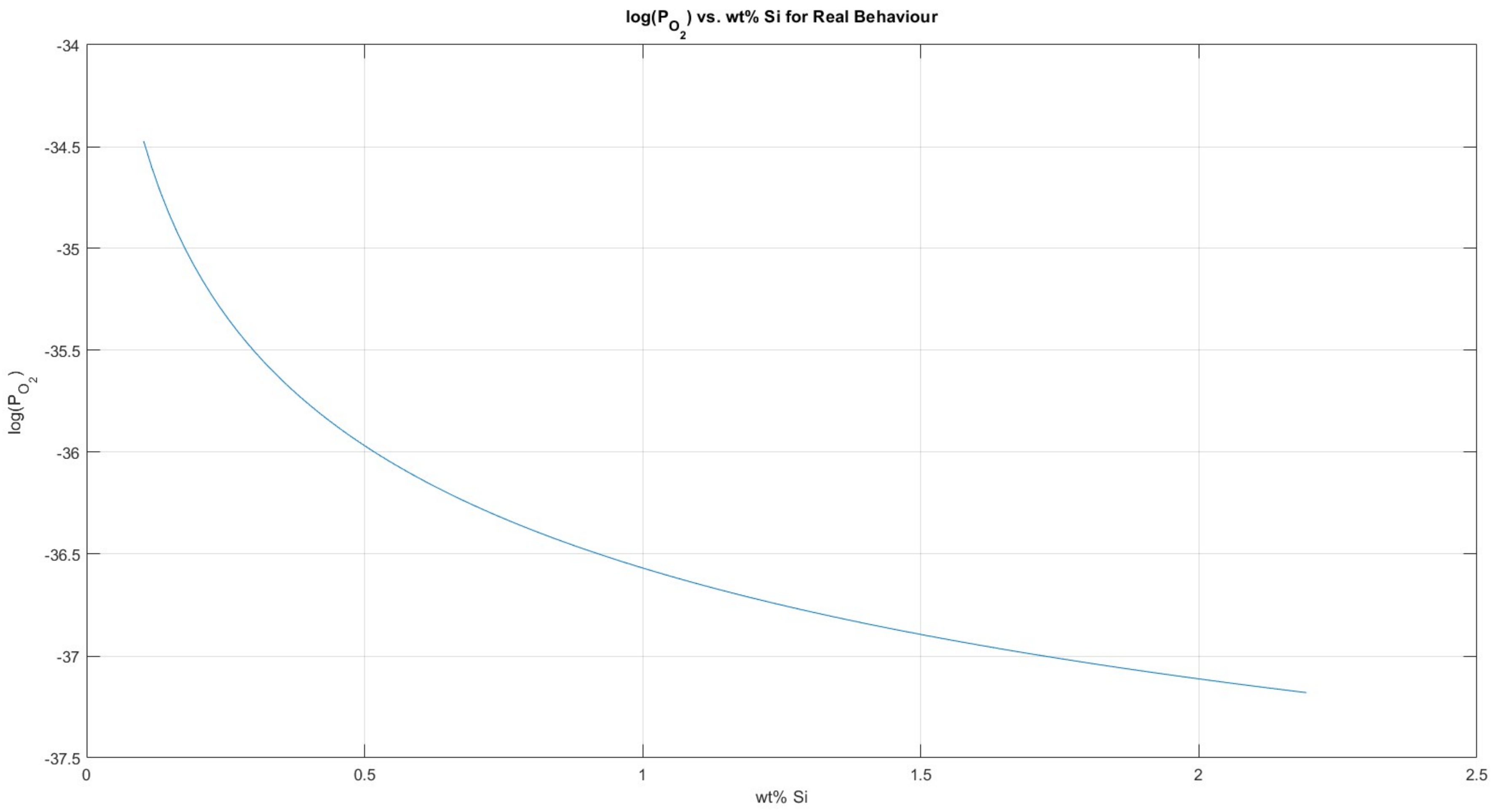
Graph of P_{O_2} vs $wt\%$ Si (Real behavior)



Graph of $ln(P_{O_2}) vs\ wt\%\ Si$ (Henrian behavior)



Graph of $ln(P_{O_2}) vs\ wt\%\ Si$ (Henrian behavior)



Iron – Carbon – Silicon Alloy

- $C_{(1\,wt\%\,in\,liquid\,Fe)} + \frac{1}{2}O_2(g) = CO(g)$
- For the above reaction delta G will be
- $\Delta G_1 = \Delta G_1^o + RTln\left(\frac{P_{CO}}{a_C * p_{O_2}^{\frac{1}{2}}}\right) \qquad (1)$
- $\{Si\} + (O_2) = \langle SiO_2 \rangle$
- For the above reaction delta G will be
- $\Delta G_2 = \Delta G_2^o + RTln\left(\frac{a_{SiO_2}}{a_{Si} * p_{O_2}}\right) \qquad (2)$

- $Si + O_2 = SiO_2 \qquad (1)$
- $2CO = 2C + O_2 \qquad (2)$
- Adding reactions 1 and 2,
- $Si + 2CO = 2C + 2SiO_2 \qquad (3)$
- Delta G for the above reaction will be
- $\Delta G = \Delta G_2 - 2\Delta G_1$

$$\Longrightarrow \Delta G = (\Delta G_2^o - 2\Delta G_1^o) + RT\left[ln\left(\frac{{a_c}^2}{a_{Si}}\right)\right]$$

- If delta G will be for the reaction 3 be negative then forward reaction will take place and if positive then backward reaction will take place.
- So I fixed the value of $a_c = 4.0\ and\ a_{Si} = 1.5$ then plotted the graph between delta G vs temperature.

Delta G vs Temperature Graph