



Title	Equilibrium between sulphur in molten iron and mixed gas of H <sub>2</sub> and H <sub>2</sub> O
Author(s)	Uno, Tatsuji
Citation	Memoirs of the Faculty of Engineering, Hokkaido University, 9(1), 91-100
Issue Date	1952-03-31
Doc URL	<a href="http://hdl.handle.net/2115/38251">http://hdl.handle.net/2115/38251</a>
Type	bulletin (article)
File Information	9(1)_91-100.pdf



[Instructions for use](#)

# Equilibrium between Sulphur in Molten Iron and Mixed gas of H<sub>2</sub> and H<sub>2</sub>O

Tatsuji U NO

(Received Aug. 31, 1951)

## Introduction

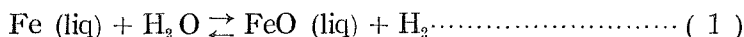
In this report, the author will describe the action of mixed gas of H<sub>2</sub> and H<sub>2</sub>O against sulphur in molten iron. Equilibrium between sulphur in molten iron and mixed gas of CO and CO<sub>2</sub> has been previously reported by the author.<sup>1)</sup>

Compared to the action of mixed gas of CO and CO<sub>2</sub> that of H<sub>2</sub> and H<sub>2</sub>O is less important but can not be neglected in the iron and steel making process.

As the reaction products of sulphur in molten iron and mixed gas of H<sub>2</sub> and H<sub>2</sub>O, H<sub>2</sub>S, SO<sub>2</sub> and S<sub>2</sub> are considered in gas atmosphere. Some molten iron should be oxidized to FeO (liq), but it is not necessary to consider the higher oxides of Fe.

As H<sub>2</sub>O content in the mixture increases, oxygen in molten iron also increases and at last it reaches its saturation point and molten FeO floats on the molten iron. Equilibrium relation of the formation of FeO has been recently determined by Sanbongi.<sup>2)</sup>

That is,



$$\log K_1 = \log \frac{p_{\text{H}_2}}{p_{\text{H}_2\text{O}}} = -2757.52/T + 1.8856 \dots \dots \dots (2)$$

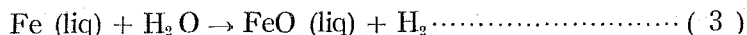
By this equation, equilibrium gas content can be calculated as follows:

temp. °C	1500	1600	1700
log p <sub>H<sub>2</sub></sub> /p <sub>H<sub>2</sub>O</sub>	0.3304	0.4134	0.4880
H <sub>2</sub> %	68.15	72.15	75.47
H <sub>2</sub> O %	31.85	27.85	25.53

Therefore when H<sub>2</sub> content at these temperatures is less than that shown in the table, molten iron is saturated with oxygen, and molten FeO floats on molten iron.

When H<sub>2</sub> content is higher, molten iron dissolves oxygen corresponding to p<sub>H<sub>2</sub></sub>/p<sub>H<sub>2</sub>O</sub> but FeO layer can not exist. Considering the true equilibrium state, as long as molten iron exists, H<sub>2</sub> content of mixed gas must be higher than that shown in

the table. But when mixed gas of higher  $H_2O$  content acts on molten iron, gas atmosphere reaches the equilibrium forming molten  $FeO$ . Therefore the reaction

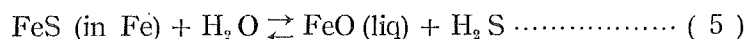
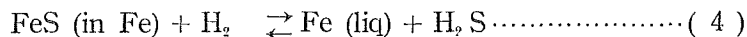


must be considered as a way to the equilibrium.

Then the gaseous products in the range of  $FeO$  forming are not said to be the products of true equilibrium.

### Formation of $H_2S$

On the formation of  $H_2S$  from sulphur in molten iron, the following reactions are considered:



Reaction (4) has been determined by the author as follows.<sup>3)</sup>

$$\log K_4 = \log p_{H_2S}/p_{H_2} \cdot [S] = -4427/T + 0.113 \dots\dots (6)$$

From this equation, values of  $\log K_4$  at 1500°C, 1600°C and 1700°C are calculated as follows.

temp. °C	1500	1600	1700
$\log K_4$	-2.384	-2.251	-2.131

As reaction (5) is obtained by combining reaction (4) with (1), from equations (6) and (2)

$$\log K_5 = \log p_{H_2S}/p_{H_2O} \cdot [S] = -7184.52/T + 1.9986 \dots (7)$$

is introduced and values of  $\log K_5$  can be calculated as follows:

temp. °C	1500	1600	1700
$\log K_5$	-2.054	-1.837	-1.643

From (6) and (7), the following equations can be obtained:

$$\log p_{H_2S} = \log K_4 + \log p_{H_2} + \log [S] \dots\dots\dots (8)$$

$$\log p_{H_2S} = \log K_5 + \log p_{H_2O} + \log [S] \dots\dots\dots (9)$$

Then if the temperature was constant,  $\log p_{H_2S}$  is determined by  $\log p_{H_2}$  or  $\log p_{H_2O}$  and  $\log [S]$ .

When  $p_{H_2} + p_{H_2O} = 1$ ,  $\log p_{H_2S}$  are calculated as follows.

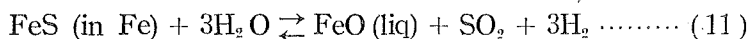
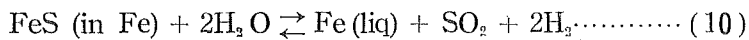
H <sub>2</sub> %	99	95	90	80	70	50	30	20	10	5	1	
H <sub>2</sub> O%	1	5	10	20	30	50	70	80	90	95	99	
S %	log p <sub>H<sub>2</sub>S</sub>											
1500°C	1	-2.388	-2.406	-2.430	-2.481	-2.539	-2.355*	-2.209*	-2.151*	-2.100*	-2.076*	-2.058*
	0.5	-2.689	-2.707	-2.731	-2.782	-2.840	-2.656	-2.510	-2.452	-2.401	-2.377	-2.359
	0.1	-3.388	-3.406	-3.430	-3.481	-3.539	-3.355	-3.209	-3.151	-3.100	-3.076	-3.058
	0.05	-3.689	-3.707	-3.731	-3.782	-3.840	-3.656	-3.510	-3.452	-3.401	-3.377	-3.359
	0.01	-4.388	-4.406	-4.430	-4.481	-4.539	-4.355	-4.209	-4.151	-4.100	-4.076	-4.058
1600°C	1	-2.255	-2.273	-2.297	-2.348	-2.361*	-2.139*	-1.993*	-1.935*	-1.884*	-1.860*	-1.842*
	0.5	-2.556	-2.574	-2.598	-2.649	-2.662	-2.440	-2.294	-2.236	-2.185	-2.161	-2.143
	0.1	-3.255	-3.273	-3.297	-3.348	-3.361	-3.139	-2.993	-2.935	-2.884	-2.860	-2.842
	0.05	-3.556	-3.574	-3.598	-3.649	-3.662	-3.440	-3.294	-3.236	-3.185	-3.161	-3.143
	0.01	-4.255	-4.273	-4.297	-4.348	-4.361	-4.139	-3.993	-3.935	-3.884	-3.860	-3.842
1700°C	1	-2.135	-2.153	-2.177	-2.228	-2.166*	-1.944*	-1.798*	-1.740*	1.689*	-1.665*	-1.647*
	0.5	-2.436	-2.454	-2.478	-2.529	-2.467	-2.245	-2.099	-2.041	-1.990	-1.966	-1.948
	0.1	-3.135	-3.153	-3.177	-3.228	-3.166	-2.944	-2.798	-2.740	-2.689	-2.665	-2.647
	0.05	-3.436	-3.454	-3.478	-3.529	-3.467	-3.245	-3.099	-3.041	-2.990	-2.966	-2.948
	0.01	-4.135	-4.153	-4.177	-4.228	-4.166	-3.944	-3.798	-3.740	-3.689	-3.665	-3.647

In this table the mark (\*) shows the results in the field in which molten FeO is produced.

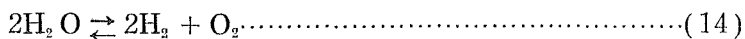
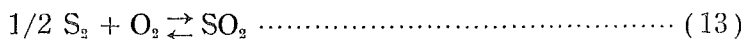
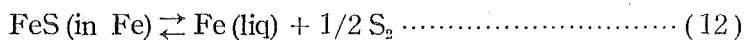
From this table, Fig 1 ~ Fig 3 can be obtained.

### Formation of SO<sub>2</sub>

On the formation of SO<sub>2</sub> by the reactions between sulphur in molten iron and the mixed gas of H<sub>2</sub> and H<sub>2</sub>O, two reactions are considered.



Reaction (10) can be introduced by combining the following three equations.



Reaction (12) has been determined by the author as follows.<sup>3)</sup>

$$\log K_{12} = \log p_{\text{S}_2}^{1/2} / [\text{S}] = -9174.3/T + 2.705 \dots\dots\dots (15)$$

The equilibrium constant of reaction (13) has been precisely determined by Lewis & Randall<sup>4)</sup> and Schenck<sup>5)</sup> gave the following equation:

$$\log K_{13} = \log p_{SO_2}/p_{S_2}^{1/2} \cdot p_{O_2} = 18215/T - 1.39 - \log T + 0.61 \times 10^{-3}T - 0.068 \times 10^{-6}T^2 - 0.20 \dots \dots \dots (16)$$

Calculating  $\log K_{13}$  between  $1400^\circ\text{C} \sim 1900^\circ\text{C}$ , the author gave a simple equation for this reaction.

$$\log K_{13} = \log p_{SO_2}/p_{S_2}^{1/2} \cdot p_{O_2} = 18115.9/T - 3.79 \dots \dots \dots (17)$$

This equation agrees well with equation (16) in this temperature range.

The equilibrium constant of the reaction (14) has been given by Schenck,<sup>6)</sup>

$$\log K_{14} = \log p_{C_2} \cdot p_{H_2}^2/p_{H_2O}^2 = -24900/T + 2.335 \log T - 0.965 \times 10^{-4}T + 0.137 \times 10^{-6}T^2 - 0.665 \times 10^{-10}T^3 + 0.1907 \times 10^{-17}T^5 - 2.17 \dots (18)$$

In the same way the author simplified this equation and obtained the following equation :

$$\log K_{14} = \log p_{O_2} \cdot p_{H_2}^2/p_{H_2O}^2 = -25500/T + 5.675 \dots \dots \dots (19)$$

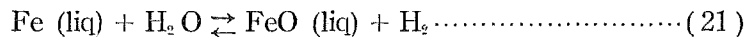
From (15), (17) and (19), for the reaction (10)

$$\log K_{10} = \log p_{H_2}^2 \cdot p_{SO_2}/p_{H_2O} = -16558.4/T + 4.590 \dots \dots \dots (20)$$

is introduced and  $\log K_{10}$  can be calculated as follows :

temp. °C	1500	1600	1700
$\log K_{10}$	-4.749	-4.251	-3.802

Reaction (11) is obtained by combining reaction (10) with the reaction



The equilibrium constant of this reaction (21) has been given by Sanbongi,<sup>2)</sup>

$$\log K_{21} = \log p_{H_2}/p_{H_2O} = -2757.52/T + 1.8856 \dots \dots \dots (22)$$

Calculating from (20), and (21) the following equation is obtained :

$$\log K_{11} = \log p_{H_2}^3 \cdot p_{SO_2}/p_{H_2O}^3 = -19315.9/T + 6.476 \dots (23)$$

By this equation,  $\log K_{11}$  can be calculated as follows :

temp. °C	1500	1600	1700
$\log K_{11}$	-4.418	-3.837	-3.314

From above results, following equations can be introduced.

$$\log p_{SO_2} = \log K_{10} + 2(\log p_{H_2O} - \log p_{H_2}) + \log [S] \dots \dots \dots (24)$$

$$\log p_{SO_2} = \log K_{11} + 3(\log p_{H_2O} - \log p_{H_2}) + \log [S] \dots \dots \dots (25)$$

Therefore,  $\log p_{SO_2}$  is a function of  $\log p_{H_2O} - \log p_{H_2}$ , or  $p_{H_2O}/p_{H_2}$ , and  $[S]$ .

When  $p_{H_2O} + p_{H_2} = 1$ ,  $\log p_{SO_2}$  is calculated as follows.

H <sub>2</sub> , %	99	95	90	80	70	50	30	20	10	5	1	
H <sub>2</sub> O, %	1	5	10	20	30	50	70	80	90	95	99	
S %	log p <sub>SO<sub>2</sub></sub>											
1500°C	1	-8.741	-7.307	-6.657	-5.956	-5.485	-4.418*	-3.314*	-2.612*	-1.556*	-0.581*	1.570*
	0.5	-9.042	-7.608	-6.958	-6.257	-5.786	-4.719	-3.615	-2.913	-1.867	-0.882	1.269
	0.1	-9.741	-8.307	-7.657	-6.956	-6.485	-5.418	-4.314	-3.512	-2.556	-1.581	0.570
	0.05	-10.042	-8.608	-7.958	-7.257	-6.786	-5.719	-4.615	-3.913	-2.867	-1.882	0.269
	0.01	-10.741	-9.307	-8.657	-7.956	-7.485	-6.418	-5.314	-4.612	-3.556	-2.581	0.430
1600°C	1	-8.243	-6.809	-6.159	-5.458	-4.987*	-3.837*	-2.733*	-2.031*	-0.975*	0.000*	2.151*
	0.5	-8.544	-7.110	-6.460	-5.759	-5.288	-4.138	-3.034	-2.332	-1.276	-0.301	1.850
	0.1	-9.243	-7.809	-7.159	-6.458	-5.987	-4.837	-3.733	-3.031	-1.975	-1.000	1.151
	0.05	-9.544	-8.110	-7.460	-6.759	-6.288	-5.138	-4.034	-3.332	-2.276	-1.301	0.850
	0.01	-10.243	-8.809	-8.159	-7.458	-6.987	-5.837	-4.733	-4.031	-2.975	-2.000	0.151
1700°C	1	-7.754	-6.360	-5.810	-5.006	-4.418*	-3.314*	-2.210*	-1.508*	-0.452*	0.523*	2.674*
	0.5	-8.055	-6.661	-6.111	-5.307	-4.719	-3.615	-2.511	-1.809	-0.753	0.222	2.373
	0.1	-8.754	-7.360	-6.810	-6.006	-5.418	-4.314	-3.210	-2.508	-1.452	-0.477	1.674
	0.01	-9.055	-7.661	-7.111	-6.307	-5.719	-4.615	-3.511	-2.809	-1.753	-0.778	1.373
	0.01	-9.754	-8.360	-7.810	-7.006	-6.418	-5.314	-4.210	-3.508	-2.452	-1.477	0.674

### Dissociation Pressure of S<sub>2</sub>

Dissociation pressure of sulphur equilibrated with S content at 1500°C, 1600°C and 1700°C is calculated as follows.

S %	log p <sub>S<sub>2</sub></sub>		
	1500°C	1600°C	1700°C
1	-4.939	-4.386	-3.890
0.5	-5.541	-4.988	-4.492
0.1	-6.939	-6.386	-5.890
0.05	-7.541	-6.988	-6.492
0.01	-8.939	-8.386	-7.890

These values have no relation to the mixing ratio of H<sub>2</sub> and H<sub>2</sub>O.

### Sulphur content in gas atmosphere

From the above calculations, at given H<sub>2</sub> % in H<sub>2</sub>-H<sub>2</sub>O mixture, gaseous sulphide which shows the greatest partial pressure is tabulated as follows. Besides this gas, some gaseous sulphides whose partial pressure is greater than 1/100 of the greatest are also described here.

H <sub>2</sub> %	99	95	90	80	70	50	30	20	10	5	1	
H <sub>2</sub> O%	1	5	10	20	30	50	70	80	90	95	99	
1500°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	1%	-2.388	-2.406	-2.430	-2.481	-2.539	-2.355	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
1500°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	0.5%	-2.689	-2.707	-2.731	-2.782	-2.840	-2.656	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	1.570
1500°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	0.1%	-3.388	-3.406	-3.430	-3.481	-3.539	-3.355	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	0.570
1500°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	0.05%	-3.689	-3.707	-3.731	-3.782	-3.840	-3.656	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	0.269
1500°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	0.01%	-4.388	-4.406	-4.430	-4.481	-4.539	-4.355	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	-0.430
1600°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	1%	-2.255	-2.273	-2.297	-2.348	-2.361	-2.139	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
1600°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	0.5%	-2.556	-2.574	-2.598	-2.649	-2.662	-2.440	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	1.850
1600°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	0.1%	-3.255	-3.273	-3.297	-3.348	-3.361	-3.139	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	1.151
1600°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	0.05%	-3.556	-3.574	-3.598	-3.649	-3.662	-3.440	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	0.850
1600°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	0.01%	-4.255	-4.273	-4.297	-4.348	-4.361	-4.139	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	0.151
1700°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	1%	-2.135	-2.153	-2.177	-2.228	-2.166	-1.944	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	2.674
1700°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	0.5%	-2.436	-2.454	-2.478	-2.529	-2.467	-2.245	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	2.373
1700°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	0.1%	-3.135	-3.153	-3.177	-3.228	-3.166	-2.944	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	1.674
1700°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	0.05%	-3.436	-3.454	-3.478	-3.529	-3.467	-3.245	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	1.373
1700°C	[S]	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>H<sub>2</sub>S</sub>	log p <sub>SO<sub>2</sub></sub>
	0.01%	-4.135	-4.153	-4.177	-4.228	-4.166	-3.944	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	log p <sub>SO<sub>2</sub></sub>	0.674

Only these gases described in this table have the decisive influence upon sulphur content in the gas atmosphere. From the fact that both H<sub>2</sub>S and SO<sub>2</sub> contain

1430g S per 1 m<sup>3</sup> and S<sub>2</sub> contains 2860g S per 1 m<sup>3</sup>, S<sub>g</sub> contained in 1 m<sup>3</sup> of the equilibrium gas is tabulated as follows,

H <sub>2</sub> %		99	95	90	80	70	50	30	20	10	5	1	
H <sub>2</sub> O %		1	5	10	20	30	50	70	80	90	95	99	
1500°C	[S] 1 %	S g/m <sup>3</sup> log S	5.8530 0.7674	5.6142 0.7493	5.3125 0.7253	4.7247 0.6744	4.1341 0.6164	6.3149 0.8004	9.5310 0.9791	13.5936 1.1334	51.0081 1.7076	387.244 2.5880	53128.8 4.7253
	[S] 0.5 %	S g/m <sup>3</sup> log S	2.9258 0.4662	2.8091 0.4483	2.6569 0.4244	2.3624 0.3734	2.0764 0.3173	3.1575 0.4993	4.7662 0.6782	6.7892 0.8324	25.5541 1.4075	193.622 2.2870	26569.4 4.4244
	[S] 0.1 %	S g/m <sup>3</sup> log S	0.5853 -0.2326	0.5614 -2.507	0.5313 -0.2747	0.4725 -0.3256	0.4134 -0.3836	0.6315 -0.1996	0.9531 -0.0209	1.3594 0.1334	5.1008 0.7076	38.7244 1.5880	5312.88 3.7253
	[S] 0.05 %	S g/m <sup>3</sup> log S	0.2926 -0.5338	0.2807 -0.5517	0.2657 -0.5956	0.2362 -0.6266	0.2076 -0.6827	0.3158 -0.5007	0.4766 -0.3218	0.6789 -0.1676	2.5554 0.4075	19.3622 1.2870	2656.94 3.4244
	[S] 0.01 %	S g/m <sup>3</sup> log S	0.05853 -1.2326	0.05614 -1.2507	0.05313 -1.2747	0.04725 -1.3256	0.04134 -1.3836	0.06315 -1.1996	0.09531 -1.0209	0.1359 -0.8666	0.5101 -0.2924	3.8724 0.5880	531.288 2.7253
1600°C	[S] 1 %	S g/m <sup>3</sup> log S	8.0666 0.9077	7.7435 0.8889	7.3345 0.8654	6.5337 0.8152	6.3449 0.8024	10.5906 1.0249	17.1743 1.2349	29.9156 1.4759	170.170 1.1309	1450.02 3.1614	202488 5.3085
	[S] 0.5 %	S g/m <sup>3</sup> log S	3.9754 0.5994	3.8188 0.5819	3.6065 0.5571	3.2089 0.5064	3.1145 0.4934	5.2967 0.7240	8.5900 0.9340	14.9578 1.1749	85.085 1.9299	724.867 2.8603	101244 5.0075
	[S] 0.1 %	S g/m <sup>3</sup> log S	0.7494 -0.0997	0.7626 -0.1177	0.7217 -0.1416	0.6416 -0.1927	0.6228 -0.2057	1.0591 0.0249	1.7174 0.2349	2.9916 0.4759	17.0170 1.1309	145.002 2.1614	20248.8 4.3085
	[S] 0.05 %	S g/m <sup>3</sup> log S	0.3975 -0.4006	0.3819 -0.4181	0.3607 -0.4429	0.3209 -0.4936	0.3115 -0.5066	0.5297 -0.2760	0.8590 -0.0760	1.4958 0.1749	8.5085 0.9299	72.4867 1.8603	10124.4 4.0075
	[S] 0.01 %	S g/m <sup>3</sup> log S	0.07949 -1.0997	0.07626 -1.1177	0.07217 -1.1416	0.06416 -1.1927	0.06228 -1.2057	0.10591 -0.9751	0.17174 -0.7651	0.29916 -0.5241	1.7017 0.1309	14.5002 1.1614	2024.88 3.3085
1700°C	[S] 1 %	S g/m <sup>3</sup> log S	10.8780 1.0366	10.4233 1.0180	9.8827 0.9949	8.8288 0.9459	10.1258 1.0054	17.3316 1.2388	31.9462 1.5044	70.7993 1.8500	534.391 2.7279	4767.62 3.6783	675103 5.8294
	[S] 0.5 %	S g/m <sup>3</sup> log S	5.3310 0.7268	5.1194 0.7092	4.8471 0.6857	4.3215 0.6353	4.9707 0.6964	8.4826 0.9285	15.8015 1.1987	35.2066 1.5466	267.124 2.4267	2383.81 3.3773	337480 5.5282
	[S] 0.1 %	S g/m <sup>3</sup> log S	1.0479 0.0208	1.0054 0.0023	0.9514 -0.0216	0.8460 -0.0726	0.9749 -0.0110	1.6974 0.2298	3.1589 0.4995	7.0428 0.8477	53.4391 1.7279	476.762 2.6783	67510.3 4.8294
	[S] 0.05 %	S g/m <sup>3</sup> log S	0.5239 -0.208	0.5027 -0.2987	0.4757 -0.3227	0.4230 -0.3737	0.4879 -0.3117	0.8483 -0.0715	1.5802 0.1987	3.5207 0.5466	26.7124 1.4267	238.381 2.3773	33748.0 4.5282
	[S] 0.01 %	S g/m <sup>3</sup> log S	0.1048 -0.9792	0.1005 -0.9977	0.09514 -1.0216	0.08460 -1.0726	0.09749 -1.0110	0.1697 -0.7702	0.3159 -0.5005	0.7043 -0.1523	5.3439 0.7279	47.6762 1.6788	6751.03 3.8294



These relations are shown in Fig. 7 ~ Fig 9.

According to these results, important gaseous sulphides produced by the reactions between sulphur in molten iron,  $H_2$  and  $H_2O$  are  $H_2S$  and  $SO_2$ . If the sul-

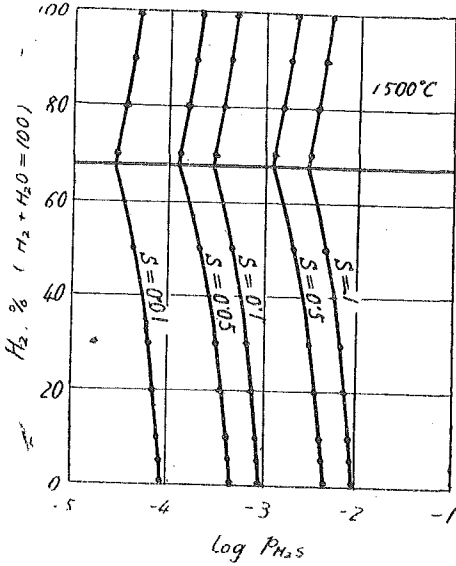


Fig. 1

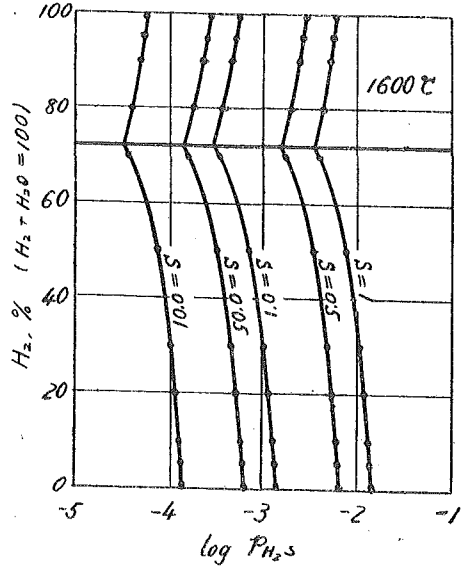


Fig. 2

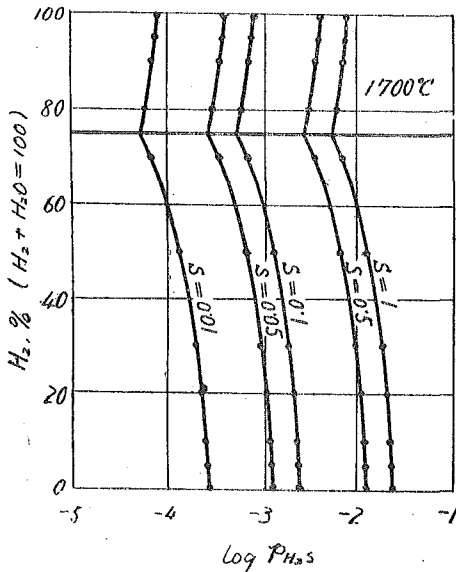


Fig. 3

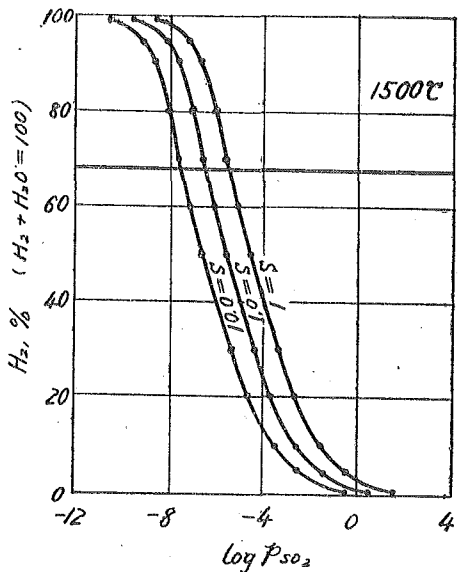


Fig. 4

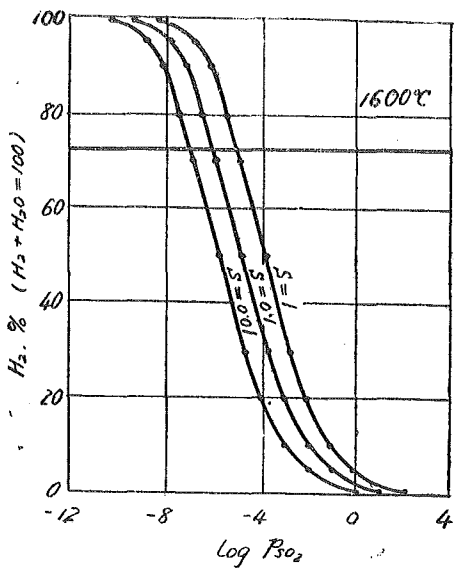


Fig. 5

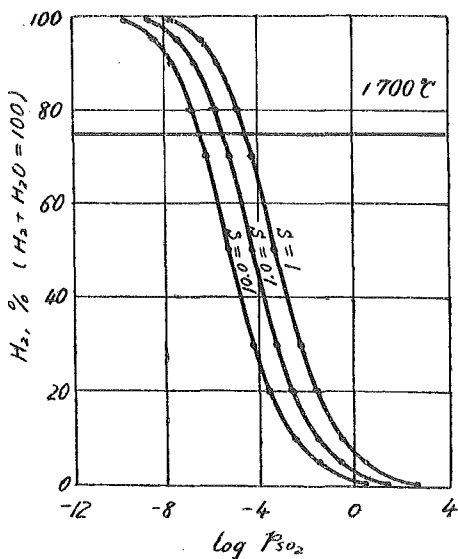


Fig. 6

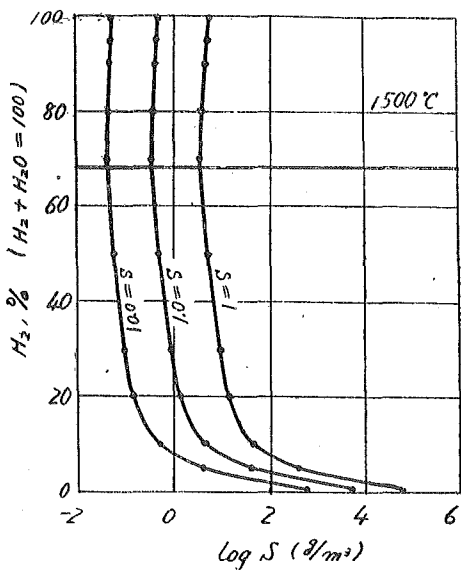


Fig. 7

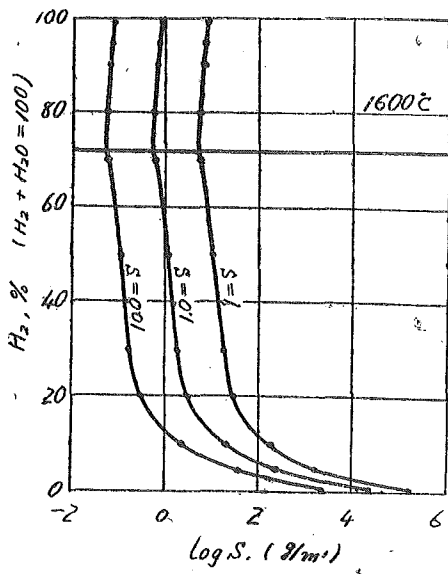


Fig. 8

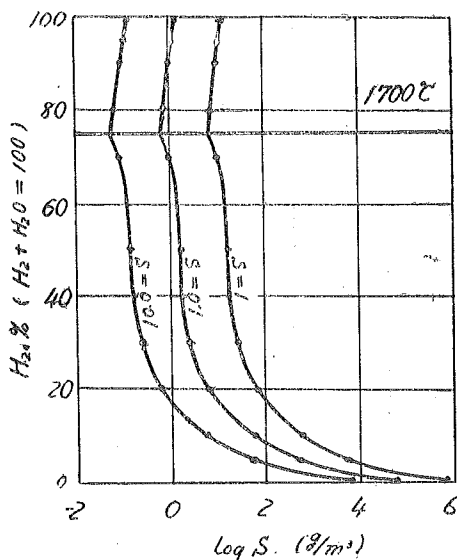


Fig. 9

phur content of molten iron was high and temperature was also high, sulphur vapor should be considered. When  $H_2O$  content in gas atmosphere is rather great, values of  $p_{S_2}$  reach very high and in these cases calculations done by the assumption that  $p_{H_2} + p_{H_2O} = 1$  can not be applied in practice. But this shows that in strong oxidizing condition, much sulphur can be contained in gas atmosphere.

### Conclusion

On sulphur dissolved in molten iron, the author has carried on the calculations like those reported in foregoing papers.

In this case, although  $H_2S$ ,  $SO_2$  and  $S_2$  may be considered as sulphides in the gas atmosphere,  $H_2S$  and  $SO_2$  are more important. When iron contains much sulphur at high temperature, vapour pressure of  $S_2$  becomes considerably large.

### References

- 1) Uno, T. ; Section Rep. Japan Inst. Metals
- 2) Sanbongi, K. ; J. Iron Steel Inst. Japan 34 (1948) 4
- 3) Matoba, S. & T. Uno ; J. Iron Steel Inst. Japan 28 (1942) 651
- 4) Lewis, G. N. & M. Randall ; Thermodynamics
- 5) Schenck, H. ; Physik. Chem. Eisenhuetten, I, (1930) 264
- 6) Schenck, H. ; Physik. Chem. Eisenhuetten, I, (1930) 160