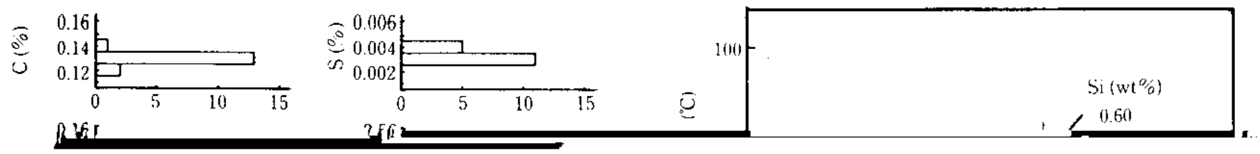
KAWASAKI STEEL TECHNICAL REPORT No. 13 September 1985

Hydrogen Attack in Cr-Mo Steels and Disbonding of Austenitic Stainless Weld Overlay*

Synopsis:

The characteristics of a hydrogen attack on $2\frac{1}{4}$ Cr-1 Mo steels were studied. Resistance to the hydrogen attack


C (%)
0.16
0.14
0.12
0
5
10
15
S (%)
0.006
0.004
0.002
0
5
10
15
100
(°C)
Si (wt%)
0.60

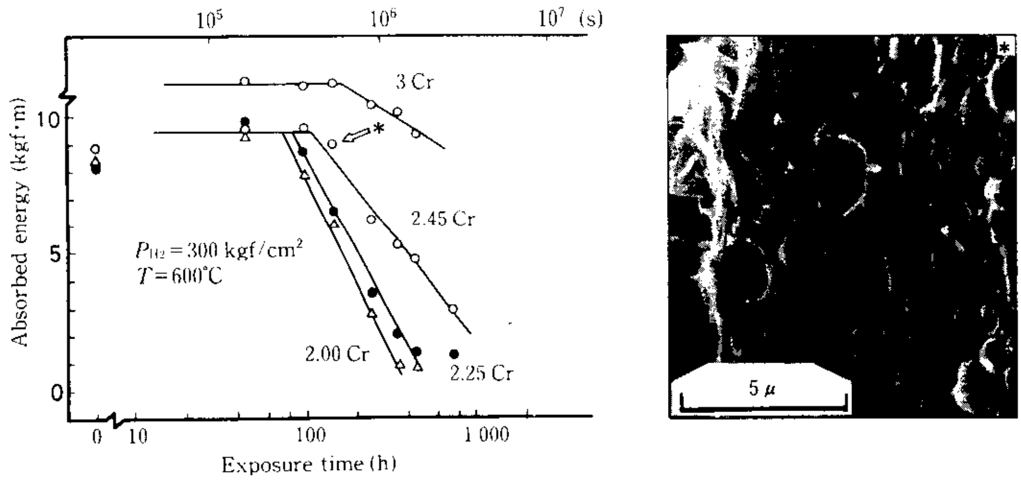
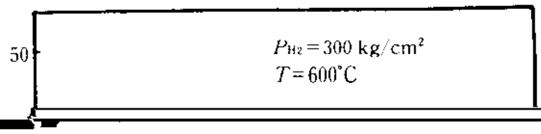


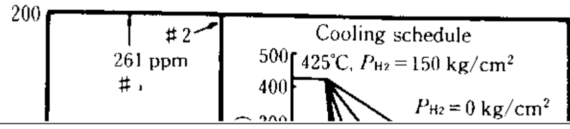
Fig. 3 Changes in absorbed energy during high temperature and high pressure hydrogen atmosphere, showing the effect of chromium content on the deterioration of toughness



ductile mode.

2.2 Shape of Carbides[1,2,5]


Weld overlay


200
2
261 ppm
Cooling schedule
500
425°C, $P_{H2} = 150$ kg/cm^2
400
$P_{H2} = 0$ kg/cm^2

because a carburized layer is not formed, even if

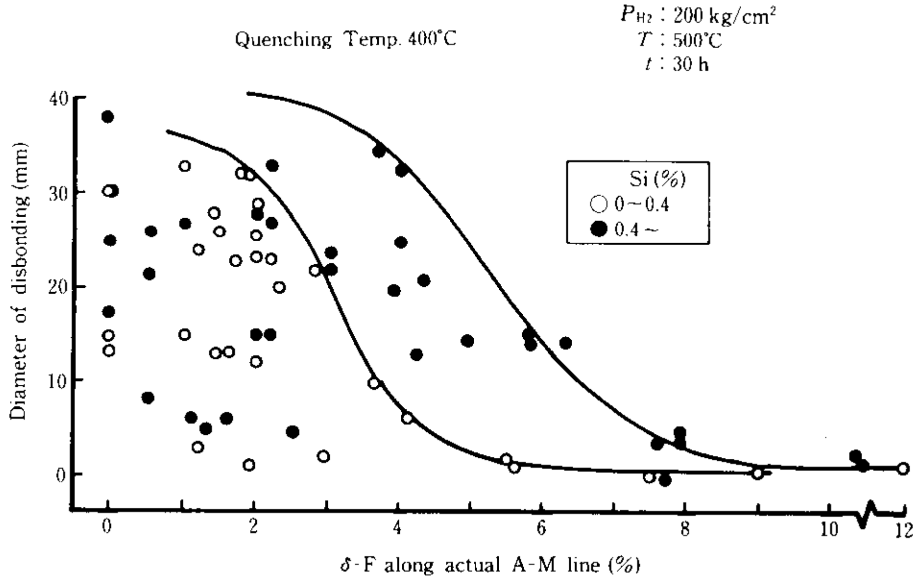


Fig. 8 Influence of silicon contents and δ ferrite contents in weld metal upon disb...

is essentially caused by the reaction:

$$2H_2 + C = CH_4. \cdots\cdots\cdots\cdots\cdots\cdots\cdots [I]$$

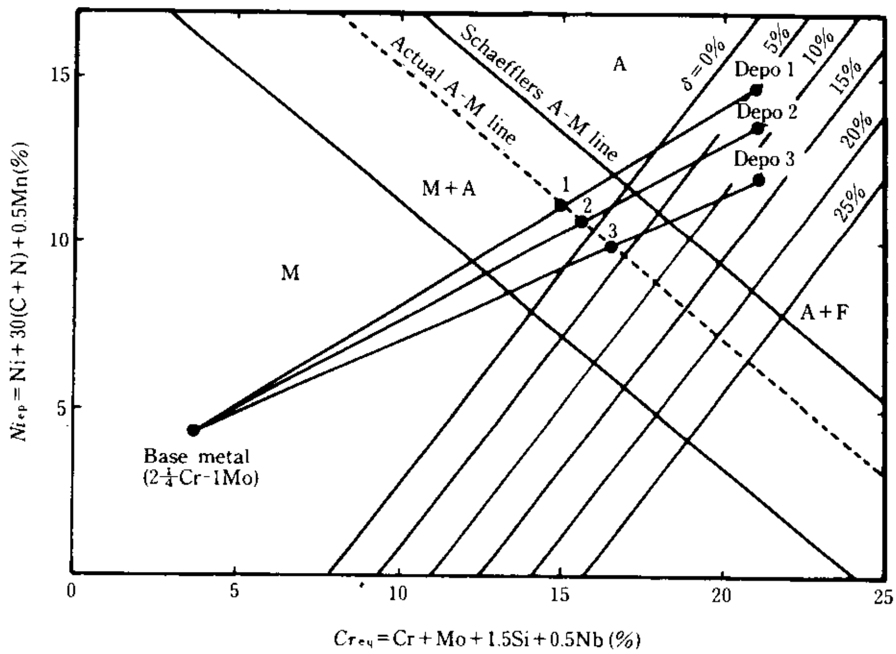
When this reactin occurs inside steel, methane is trapped at the phase boundaries, forming voids which eventually grow and link, developing into large cracks.

hydrogen, respectively. The above-mentioned effect of Si on the kinetics of hydrogen attack and the significant effect of a slight Cr content difference on susceptibility to hydrogen attack must be explained by a difference in K^{II} in Eq. (7).

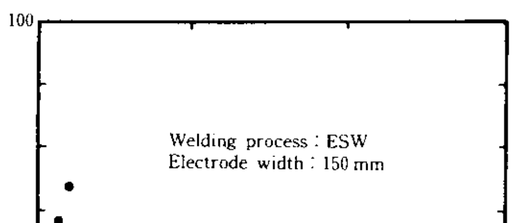
The partial pressure of methane is decisively

$$\Delta G^1 = -16520 + 12.25T \log T$$

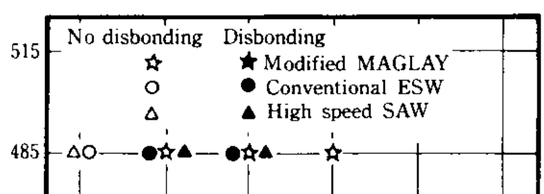
Hence, f_{CH_4} is 211 kgf/cm² for 2Cr-1Mo steel and



Schaefflers A-M line
Actual A-M line
A
M+A
M
A+F
δ=0%
5%
10%
15%
20%
25%
Depo 1
Depo 2
Depo 3
1
2
3
Base metal
(2¼Cr-1Mo)
Ni_{eq} = Ni + 30(C + N) + 0.5Mn(%)
Cr_{eq} = Cr + Mo + 1.5Si + 0.5Nb (%)
0
5
10
15
20
25



100
Welding process : ESW
Electrode width : 150 mm



No disbonding Disbonding
515
485
Modified MAGLAY
Conventional ESW
High speed SAW

demonstrate that the modified MAGLAY method

which properly controls the Si and δ-ferrite contents ensures the production of weld metal excellent in disbonding resistance.

Pressures in Petroleum Refineries and Petrochemical Plants,"

No. 941, 2nd ed., API, June (1977)

5) T. Imanaka: "Effect of Cr Content on Hydrogen Attack of Cr-Mo Steels", *Preprint of Fall Meeting of the Japan Institute of Metals*, (1984), p. 469

6) F. K. Naumann: "Der Einfluß von Legierungszusätzen auf

7) T. Imanaka and S. Sato: "Effect of Vanadium on Hydrogen