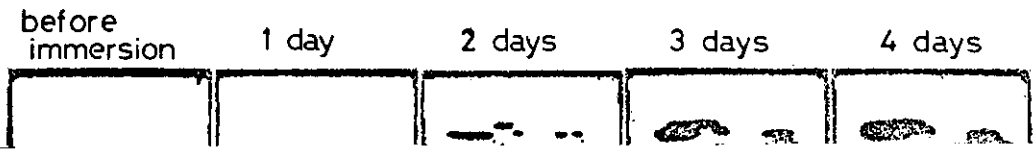
2 Evaluation of Susceptibility to HIC

A laboratory scale method suitable to assess the susceptibility to HIC under wet hydrogen sulfide environment has been developed recently by H. C. Cotton of the British Petroleum Company[19,20]. This test is called "B.P. Test" and is now widely adopted to evaluate the susceptibility to HIC for linepipe steels. The standard test conditions for the B.P. test are shown in Table 1. These conditions are considered to

by microscopy as shown in **Figs. 1** and **2**.

The susceptibility to HIC was evaluated by three different ways, *i.e.*, (1) Ratio of crack area by UST, (2) Ratio of crack length, (3) Cracking sensitivity ratio, as shown in **Figs. 1, 2** and **3**. In the measurement of the cracking sensitivity ratio, it is necessary to distinguish between the straight cracks and the stepwise cracks. In this work, when one crack is located within the circle with radius of 0.5 mm centered at an end of another crack, as shown in Fig. 3, the two cracks are


before immersion
1 day
2 days
3 days
4 days

crack in through-thickness direction is developed, the steel of which the ratio of crack area by UST is less than 20 % can be considered to be the steel highly resistant to HIC.

In evaluating the susceptibility to HIC for steels of commercial scale production, it is found to be very important to specify the sampling position of the

3 Metallographic Examination

The typical blisters observed on the surface of the specimen subjected to the B.P. test shown in **Table 1** are shown in **Photo. 1**. The cross sectional view shows that the blistering is caused by the cracks near the surface and most of these cracks are stepwisely con-

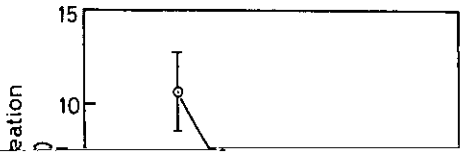

Segregated zone of Mn and P

occur in the segregation zone of Mn and P during the cooling of plates after hot rolling.

The scanning electron micrograph of the fractured surface of the straight crack, as shown in **Photo. 4**, shows that the fracture is sub-cleavage configuration, the same as the hydrogen embrittlement fracture in steels.

As described before, there are three types of crack, *i.e.*, blister, straight crack and stepwise crack. Some researchers[19,20] claim that only the stepwise crack is

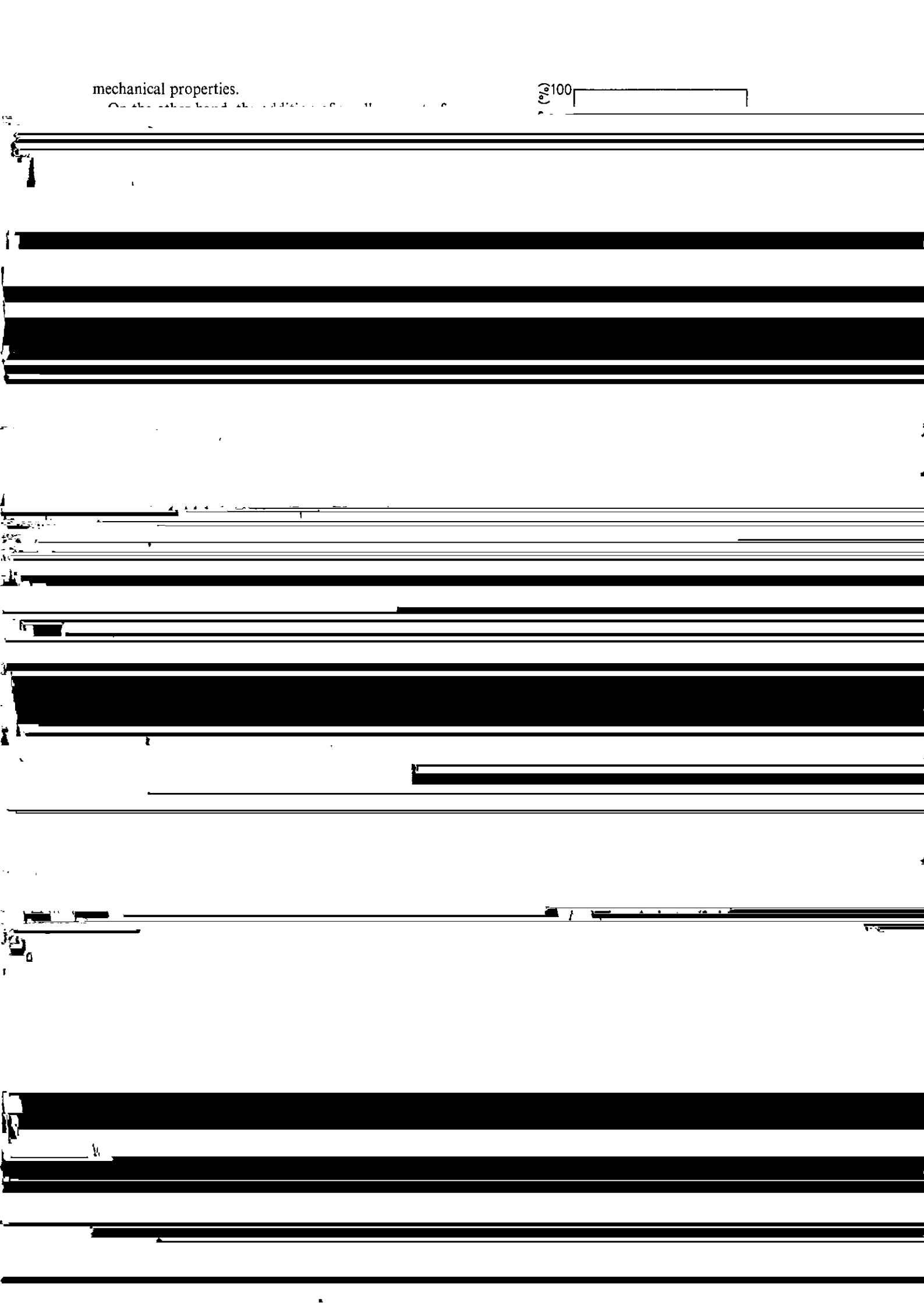
examinations to improve the resistance to HIC will be described in this section.

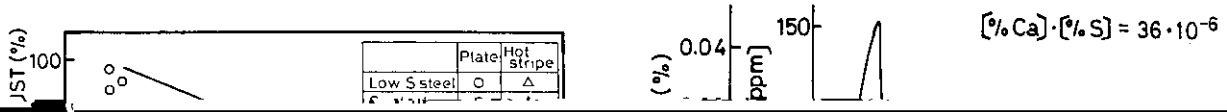


4.1 Effect of Alloying Elements on Entrance of Hydrogen into Steel

especially for the control rolled plates markedly with as semi-killed and Si-killed steels, type *I* MnS is pre-

mechanical properties.




JST (%)
100
Plate
Hot stripe
Low S steel
O
Δ
(%)
0.04
[ppm]
150
[%Ca]·[%S] = 36·10⁻⁶

is less than 20 % can be considered highly resistant to HIC, as discussed in *Chapter* **2**. Furthermore, when

trolled nine. Furthermore, it is confirmed that the

4) T. Skei, A. Wachter, W.A. Bonner and H.D. Brunham: Corrosion, 9 (1953), p. 163

5) W. Dahl, H. Stoffels, H. Hengstenberg and C. Duren: Stahl u. Eisen, 87 (1967), 3, p. 125

6) T. Murata, K. Yukawa, H. Tamura, E. Satoo and H. Okada: Tetsu-to-Hagané, 6, (1975), A, S235

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(1973), p. 475

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