Corrosion Resistant High Cr Steel for Oil and Gas Wells†

1. Introduction

Oil and natural gas development in high temperature and high pressure environment or high corrosive environment in deep well has continued to increase in recent years. While high strength and high corrosion resistant oil country tubular goods (OCTG) are necessary under these conditions, demand for cost reduction to improve the profitability of oil and gas development is increasing. Moreover, larger fluctuations and a shorter cycle of change in crude oil and gas prices have heightened the focus on short-term recovery of development costs, and short delivery deadline requirements are also increasing.

JFE Steel is responding to the above-mentioned customer needs by developing high Cr stainless steel seamless OCTG that can provide high strength and high corrosion resistance while also meeting requirements for low cost and short delivery deadlines. The following introduces the JFE Steel's product line in detail.

2. High Cr Stainless Steel OCTG

2.1 Product Line

The problem of corrosion in OCTG can be broadly divided into CO_2 corrosion under sweet (CO_2) conditions and sulfide stress cracking (SSC) under sour (H_2S) conditions. Sweet (CO_2) conditions can be further divided into a pure sweet (CO_2) condition and a CO_2 + slight H_2S condition ($H_2S \leqq 0.01$ MPa). The materials applied under those conditions are 13% Cr steel (API-L80-13Cr, API: The American Petroleum Institute), modified 13% Cr steel, duplex stainless steel, and Ni based alloys. To date, JFE Steel has offered a product line from 13% Cr steel to modified 13% Cr steels (JFE-HP1-13CR, JFE-HP2-13CR). Recently, JFE Steel also developed new high Cr stainless steel OCTG with high strength and corrosion resistance[1–5], which can be economical substitutes for the existing materials. The applicable conditions of JFE Steel's high Cr stainless steel OCTG are shown in **Fig. 1** from the viewpoint of CO_2 corrosion resistance and sour resistance. The chemical compositions and mechanical properties of these high Cr steels are shown in **Tables 1** and **2**, respectively.

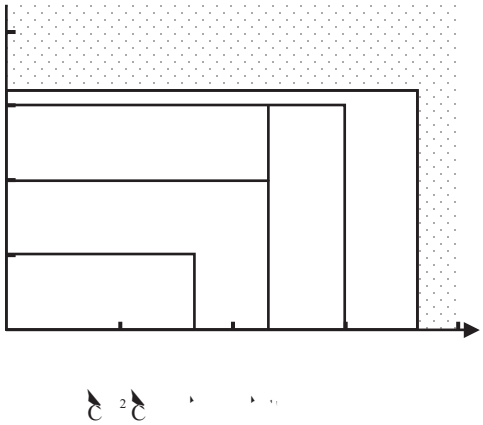

Table 1 Chemical composition of high Cr steels

(mass%)

Material	C	Cr	Ni	Mo	Others
JFE-13CR	0.15–0.22	12.0–14.0	Max. 0.50	—	Cu: Max. 0.25
JFE-11CR	Max. 0.04	10.0–12.0	2.0–3.0	—	Cu: Max. 0.60
JFE-HP1-13CR	Max. 0.04	12.0–14.0	3.5–4.5	0.8–1.5	—
JFE-HP2-13CR	Max. 0.04	12.0–14.0	4.5–5.5	1.8–2.5	—
JFE-UHP™-15CR	Max. 0.04	14.0–16.0	6.0–7.0	1.8–2.5	Cu: Max. 1.50
JFE-UHP™-17CR	Max. 0.04	16.0–18.0	3.5–4.5	2.3–2.8	Cu: Max. 1.50 W: 0.80–1.20