# 2. 고장력강의 해양환경중 기계적 · 전기화학적 특성에 미치는 용접후열처리 효과

기관공학과 김 성 종
지도교수 문 경 만

Off-shore structures experienced in severe marine environment such as waves, sand, storm and tide, should be protected against corrosion in an approprite way, especially at steel welded parts. Cathodic protection(CP) has been widely adopted as the most effective protection technique in marine environment from a practical and economical point of view. Impressed current cathodic protection(ICCP) method, one of the CP technics, is being popularly used in marine structures. ICCP, however, has a risk of hydrogen embrittlement when over-protected. This hydrogen embrittlement can cause more trouble in high strength steels, particularly welded parts. It is suggested, therefore, that the limit potential against hydrogen embrittlement should be examined in detailed as a function of CP potential.

In this study the effect of post-weld heat treatment(PWHT) for RE36 steel, one of the high strength steels for marine structures, was investigated with parameters such as micro-vickers hardness, corrosion potential, corrosion current density. The welded area devided into three parts, weld metal(WM), base metal(BM) and heat affected zone(HAZ). When the welded part was protected by Al alloy sacrificial anode, the current generated by Al alloy anode and the weight loss of Al anode were measured.

In addition, slow strain rate test(SSRT) was carried out to investigate both electrochemical and mechanical properties by post-weld heat treatment(PWHT) effect.

**Determination of the optimum post-weld heat treatment temperature**

Hardness of the PWHT specimens was lower than that of As-welded condition in all regions, BM, WM and HAZ. Regardless of PWHT temperature, hardness was the highest at HAZ among those three parts, and corrosion potential was the highest at WM.

The variation of both corrosion potential difference and corrosion current density among the three parts in PWHT condition was smaller than that in As-welded one. Eventually, it was known that corrosion resistance was improved by PWHT. When the RE36 steel is cathodically protected by Al sacrificial anode, both the current generated by Al anode and the quantity of anode weight loss were decreased by PWHT compared to As-welded condition.

Conclusively, it was revealed that in the point of both corrosion resistance and cathodic protection effect, the optimum PWHT temperature was 550℃.

**Solw strain rate test(SSRT) results for the no-notch specimens by flux cored arc welding(FCAW)**

The optimum CP potential by SSRT was ranged from -770mV to -875mV(SCE).

Through the SEM fractography analysis, the fracture morphology was dimple pattern with ductile fracture at the applied CP potential of between -770mV and -875mV(SCE), while it was transgranular pattern(Q.C : quasi cleavage) under -900mV(SCE).

It is concluded, therefore, that the CP potential occurring hydrogen embrittlement was under -900mV(SCE).

**Solw strain rate test results of base metal specimens by flux cored arc welding(FCAW)**

The optimum CP potential by SSRT was -770mV(SCE). Through the SEM fractography analysis, at the applied CP potential of -770mV(SCE), the fracture morphology was dimple pattern with ductile fracture, while it was transgranular pattern(Q.C : quasi cleavage) under -850mV(SCE).

It is represented, therefore, that the CP potential occurring hydrogen embrittlement was under -850mV(SCE).

**Solw strain rate test results of heat affected zone specimens by flux cored arc welding(FCAW)**

The optimum CP potential range by SSRT in each case was as follows :

i ) As-welded specimen : -770mV ~ above -850mV(SCE).

ii) PWHT specimen : -770mV ~ -850mV(SCE).

Through the SEM fractography analysis,

i ) in case of As-welded specimen, when applied CP potential is -770mV, the fracture morphology was dimple pattern with ductile fracture, while it changed transgranular pattern(Q.C : quasi cleavage) under -850mV(SCE).

ii) in case of PWHT specimen, when applied CP potential is between -770mV and -850mV(SCE), the fracture morphology was dimple pattern with ductile fracture, while it changed transgranular pattern(Q.C : quasi cleavage) under -875mV(SCE).

It is suggested, therefore, that the CP potential occurring hydrogen embrittlement was under -850mV for As-welded specimen and under -875mV for PWHT one.

**Solw strain rate test results of heat affected zone specimens by shielded metal arc welding(SMAW)**

The optimum CP potential by SSRT ranged between -770mV and -850mV(SCE).

Through the SEM fractography analysis, at the applied CP potential between -770mV and -850mV(SCE), the fracture morphology was dimple pattern with ductile fracture, while it changed transgranular pattern(Q.C : quasi cleavage) under -875mV(SCE).

It is suggestted, therefore, that the CP potential occurring hydrogen embrittlement was under -875mV(SCE).