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INTERFACIAL MORPHOLOGY AND DESCALING OF REHEATED STAINLESS STEEL

By

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ABSTRACT

During the steel-making process, scale is formed in the reheating furnace (on hot-rolled steel products) and is used to oxidize away some surface imperfections, but if the resultant scale cannot be removed prior to rolling (by the usual method of hydraulic descaling), then serious surface quality problems can arise. Experimental results are presented that test the hypothesis that the descaling behavior of slabs following reheating is controlled by interfacial roughening at the scale-steel interface. In this investigation, two stainless steels were considered: type 304 (austenitic, with 18% Cr and 8% Ni) and type 412 (ferritic / martensitic, with 11.6% Cr).

It was found that the entanglement that arose at the scale-steel interface was in fact effective in maintaining scale-steel adhesion, under the mechanical descaling conditions used. In the case of type 304, descaling proceeded by fracture along chromite layers, which formed on the austenite grain boundaries; for this steel, the extent of descaling depended most strongly on austenite grain size, and not primarily

on the conditions in the reheating furnace. In contrast, type 412 samples descaled only at the edge of the entangled zone, and showed a greater sensitivity to the reheating conditions.

Key terms: Interfacial morphology, reheated stainless steel, iron oxide, scale, mechanical descaling, reheating gas atmosphere, oxidation, surface quality, austenite grain structure, excess oxygen

INTERVLAKMORFOLOGIE EN ONTSKALING VAN HERVERHITTE ROESVRYSTAAL

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OPSOMMING

Gedurende die staalverwerkingsproses word skaal in die herverhittingsoond gevorm, wanneer platblokke voor warmwalsing verhit word. Skaalvorming word gebruik om oppervlakdefekte weg te oksideer, maar as die gevormde skaal nie voor walsing verwyder word nie, kan ernstige oppervlakgehalteprobleme ontstaan; die gebruiklike metode om die skaal te verwyder is om met hoëdrukwatersproeiers. Eksperimente is uitgevoer om die hipotese dat die onskalingsgedrag van herverhitte platblokke deur die ruheid van die skaal-staalintervlak beheer word, te toets. Twee tipes roesvrystaal is gebruik: tipe 304 (austenities met 18% Cr en 8% Ni) en tipe 412 (ferrities/martensities, met 11.6% Cr).

Dit is gevind dat verstrengeling tussen skaal en staal (by die intervlak) effektief was om die skaal aan die staal te heg gedurende warm meganiese onskaling. In die geval van tipe 304 het ontskaling deur kraking langs chromietlae wat op die austenietkorrelgrense gevorm het, plaasgevind; vir hierdie tipe staal was die omvang van ontskaling dus grootliks van die austenietkorrelgrootte afhanklik, en nie primêr van toestande in die herverhittingsoond nie. In teenstelling het tipe 412-monsters by die buitegrens van die verstrengelde gebied ontskaal, en het ook 'n groter invloed van die herverhittingstoestande getoon.

Sleutelwoorde: intervlakmorfologie, herverhitting, roesvrystaal, ysteroksied, skaal, meganiese ontskaling, herverhittingsoondatmosfeer, oksidasie, oppervlakgehalte, austenietkorrelstruktuur

NOMENCLATURE

P (Pa)	Impact pressure of descaling jet
T	Temperature
ρ (kg/m^3)	Density of water
G (m^3/s)	Volume flow rate of water
t (m)	Thickness of jet
B (m)	Width of steel being descaled
v (m/s)	Speed of steel under jet
θ (^{0})	Angle of jet from vertical
ρ_s (kg/m^3)	Density of scale
α (°C^{-1})	Coefficient of thermal expansion of scale
C (J/kg °C)	Specific heat capacity of scale
E (N/m^2)	Elastic modulus of scale
k (W/ m °C)	Thermal conductivity of scale
x (m)	Thickness of scale
l (m)	Distance between through scale cracks
σ (J/ m^2)	Energy required to separate scale from steel
ε_C	Compressive strain to failure of scale
ε_T	Tensile strain to failure of scale
J (N/m^2)	Shear strength of scale / metal interface

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