

Effect of Water Jet Nozzle Lead Angle on Descaling Efficiency

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ABSTRACT

Nozzle design, water pressure, and lead angle are critical for efficient descaling. In the industry, scale removal through water jet descaling using a nozzle lead angle of 15° is considered as optimal. However, variations in scale removal efficiency were not quantified. Experiments were performed using a laboratory CNC-controlled descaling system. Low- alloy steel plates were reheated at 1065°C in an atmosphere-controlled induction furnace and then descaled using two nozzle types and three attack angles in all cases. Statistical characterization of residual oxide coverage was performed using SEM analysis in a cross-section of the plate. Recommendations to increase descaling efficiency are presented.

Keywords: Descaling, Oxides, Nozzles, Attack-angle, SEM

1. INTRODUCTION

Oxide scale growth due to high-temperature oxidation during steel making process is an unavoidable challenge in the industry. This phenomenon presents limitations for final finishing processes. Studies have shown that over 5 pct. of hot rolled metal (plates/sheets) are internally recycled due to residual oxide scale and this disrupts other downstream manufacturing processes [2]– [8]. Scale removal is a necessary part of the steel-making process. The surface quality of the reheated billets depends on the efficiency of the descaling process, especially in continuous casting (CC) where hot rolled sheets and plates with as-cast surfaces are subjected to a reheating process.

The special nozzles incorporated into a high-pressure water system are used for in-line descaling. A high-pressure descaling involves a powerful pump that intensifies the pressure of the water, which is propelled through a nozzle at high velocity. The high-pressure water stream is directed at the surface to be cleaned, and the force of the water is strong enough to blast away oxide scale and dirt. Practical observations of the high-pressure hydraulic descaling process indicated that impact pressure, water consumption, and lead angle are the most important factors affecting descaling efficiency. Given the multilayer structure of a typical scale structure with randomly oriented defects (porosity and cracks) the mechanism of descaling process is very complicated [2], [8]– [14]. Three major descaling mechanisms are considered: (i) mechanical hammering by water droplets, (ii) shear forces, and (iii) localized in defect exploded high- pressure water vapor. The first two mechanisms are considered to be major, depending on water jet surface interaction, and could be controlled by the descaling system design.

The motivation for this work is to establish the influence of nozzle design and lead angle on the efficiency of oxide scale removal in the steel-making process.