

## Improving Steel Cleanliness Through Deoxidation Practice on EAF Tapping

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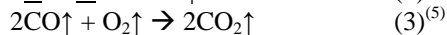
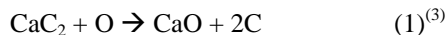
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### INTRODUCTION

Vallourec & Sumitomo Tubos do Brasil's (VSB) steelmaking plant started operating on August 2011 to produce 270 mm, 310 mm and 406 mm diameter round bars that are used to roll seamless OCTG (Oil Country Tubular Goods) and Line Pipe products. Those are used on casing and conducting oil and gas, attending API 5L and 5CT standards. Steel cleanliness plays an important role on mechanical and resistance to corrosion properties of these tubes.

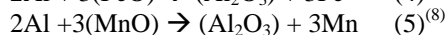
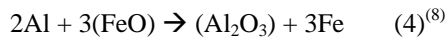
High amounts of inclusions in the steel can cause it to lose mechanical and resistance to corrosion properties<sup>(1)</sup> and this is specially drastic for high quality products such as OCTG. Therefore, it is important to develop deoxidation practice that is capable of decreasing inclusion formation, preventing slag oxidation and increasing slag inclusion absorption.

During steel killing using aluminum, the reaction between this element and oxygen produces alumina inclusions (Al<sub>2</sub>O<sub>3</sub>). Most of these inclusions are capable of floating to the slag by density difference but, the smaller the inclusion, the harder it is for them to float.<sup>(2)</sup> It is important to keep the amount of oxygen and aluminum in the steel in low level. For that to be done, one option is to substitute part of aluminum by another deoxidizer, such as calcium carbide. This intake reacts with oxygen in three different steps as shown on reactions 1<sup>(3)</sup>, 2<sup>(4)</sup> and 3<sup>(5)</sup>.



Inclusion absorption is related to slag viscosity. The use of calcium carbide (CaC<sub>2</sub>) and its reaction with the FeO and MnO of an oxidized slag produces CO that helps its foaming and, by so doing, controlling its viscosity.<sup>(3)</sup>

When it comes to steel cleanliness, another important topic is keeping the %FeO+%MnO proportion low in the slag (<2.0%)<sup>(6,7)</sup> as to keep it deoxidized. High quantities of FeO+MnO can make steel alloying elements – such as Al – react as shown below on reactions 4 and 5 and form inclusions mainly during secondary refining.



A series of experiments with two patterns of deoxidizer addition using Al and CaC<sub>2</sub> were held during VSB's Electric Arc Furnace (EAF) tapping as to improve steel cleanliness and slag oxidation.